Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

JUNE 1951

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MESTA heavy duty ROLL GRINDERS

Color Photo by E. D. MESTA

Mesta Roll Grinders of simplified design are the most accurate and dependable grinding machines available today. Built with precision for the finest finishing and with ruggedness for the heaviest roughing.

DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS

MESTA MACHINE COMPANY · PITTSBURGH, PA.

what are the FACTS ABOUT SAFETY SWITCHES?

1 IS "INTERNAL HEATING" IN SAFETY SWITCHES IMPORTANT?

Engineering research fully authenticated by outstanding authorities shows "internal heating" in Safety Switches to be the principal cause of Safety Switch failures.

2 HOW DOES "INTERNAL HEATING" CAUSE SAFETY SWITCH FAILURES?

By literally baking the life out of Safety Switch parts. It causes insulating materials to disintegrate, metal parts to warp and corrode, so switches either become inoperative or "burn up" through inability to carry the load.

3 WHAT CAUSES "INTERNAL HEATING" IN SAFETY SWITCHES?

In properly constructed Safety Switches, fuses are responsible almost exclusively for "internal heating." This is no criticism of fuses; it is unavoidable. Any fuse carrying its rated load *must* be near its melting point if it is to perform properly when an overload occurs. Any metal operating *near* its melting point must be *hot* and fuse links *are* hot, with temperatures running as high as 700 degrees Fahrenheit.

4 HOW CAN THE TROUBLE FROM "INTERNAL HEATING" BE OVERCOME?

As the adequate enclosure so fundamental to *safety* in Safety Switches makes thorough venting of the trapped heated air impossible, the only escape from the ravages of "internal heating" can come through selecting materials for the internal structure and designing this structure to successfully withstand the unavoidable heat conditions to be met in service.

CUTLER-HAMMER
SAFETY SWITCHES
C-H

5 WHAT SAFETY SWITCHES AVOID "INTERNAL HEATING" TROUBLES?

Cutler-Hammer Safety Switches. Cutler-Hammer Safety Switches were completely redesigned *ten years* ago to beat "internal heating" when engineering research clearly indicated the need for *such* Safety Switches. Nine years of experience shows the Cutler-Hammer claim of better Safety Switch performance far more than a mere promise; it is a proven *fact*. Ask the men who use them. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wis.

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 28, No. 6

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which makes possible the CONTINUOUS COATING LINES

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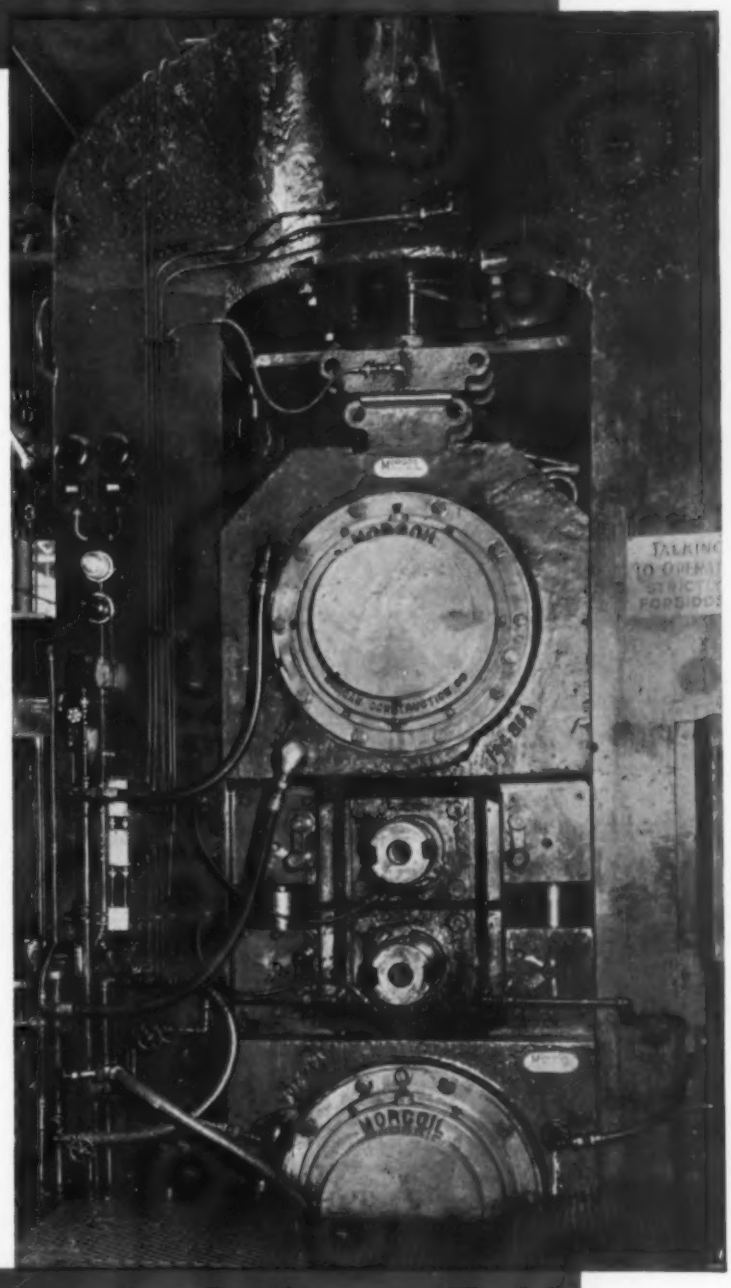
BACK-UP ROLL NECKS RUN SMOOTHER



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A Texaco Lubrication Engineer will gladly help you improve performance and reduce costs throughout your mill. Just call the nearest of the more than 2.000 Texaco Distributing Plants in the 48 States, or write The Texas Company, 135 East 42nd Street, New York 17, N. Y.

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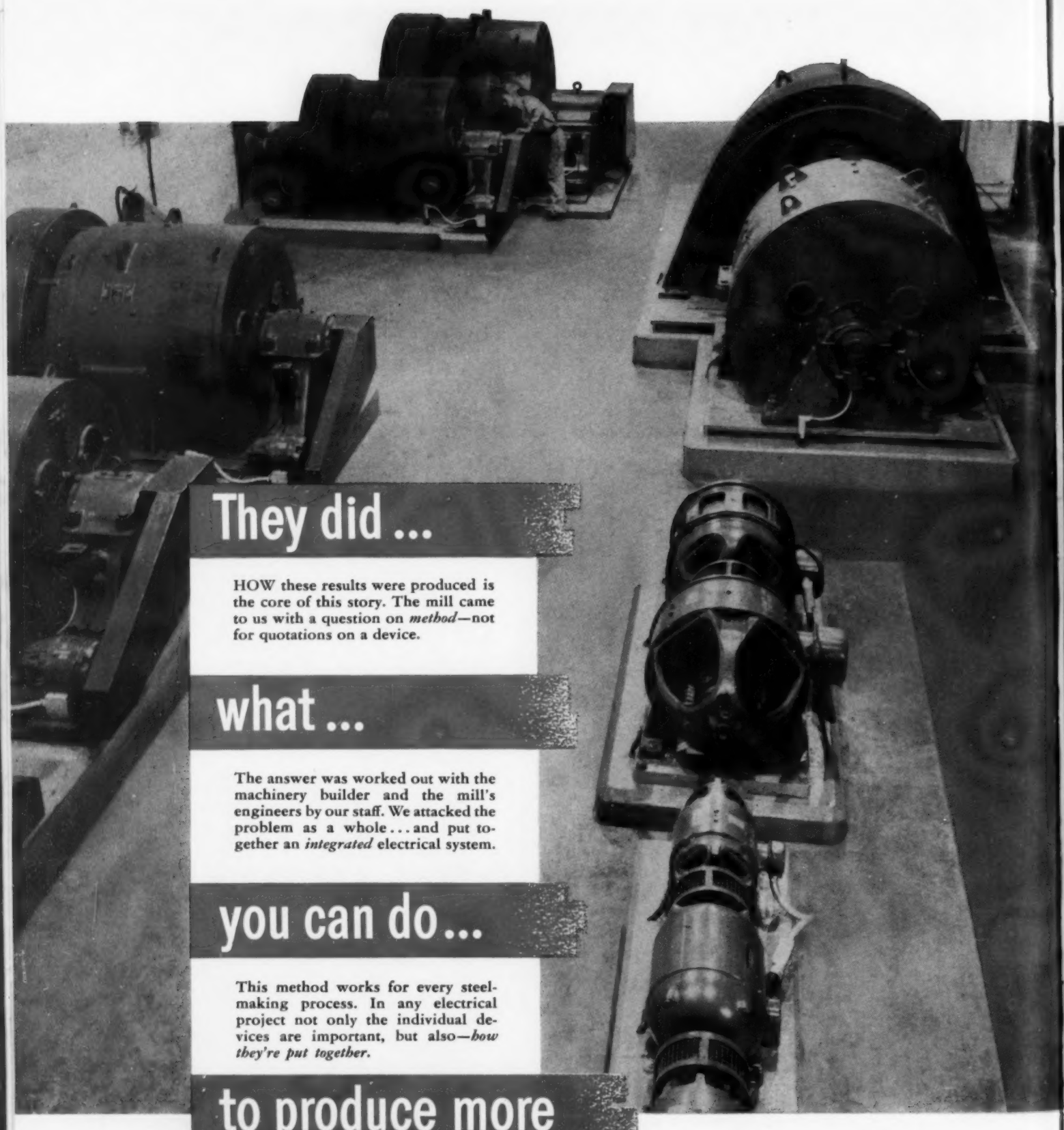
TEXACO Regal Oils

(HEAVY CIRCULATING OILS)



They did ...

HOW these results were produced is the core of this story. The mill came to us with a question on *method*—not for quotations on a device.

what ...

The answer was worked out with the machinery builder and the mill's engineers by our staff. We attacked the problem as a whole ... and put together an *integrated* electrical system.

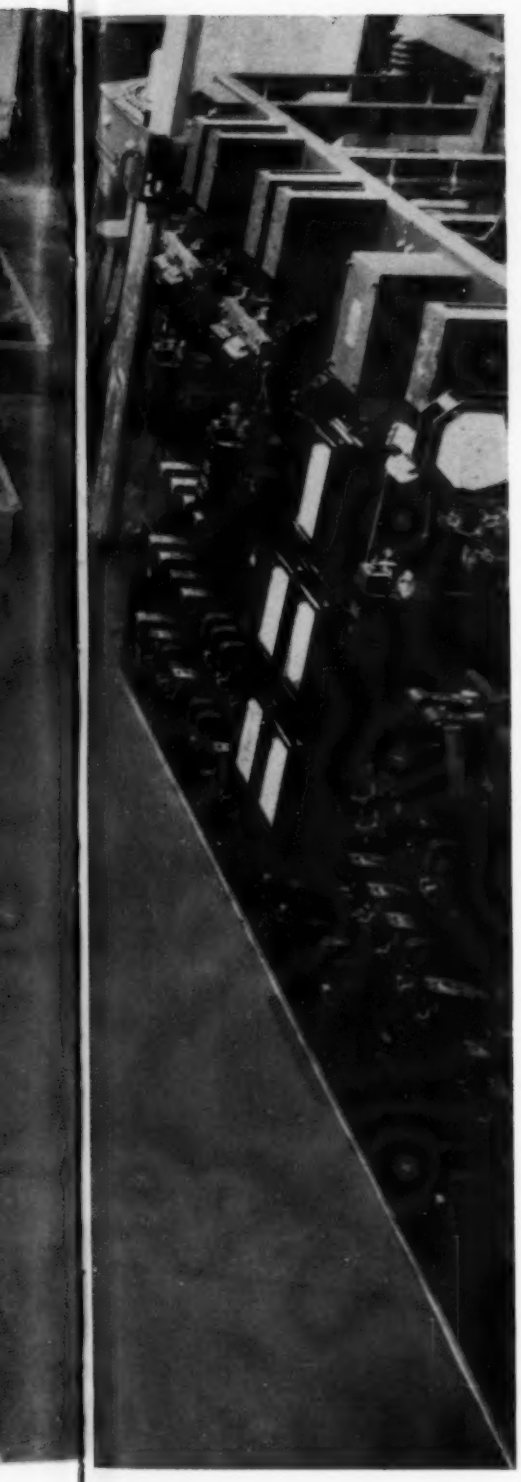
you can do ...

This method works for every steelmaking process. In any electrical project not only the individual devices are important, but also—*how they're put together.*

to produce more

Developing integrated electrical systems that help raise steel production has been one of our major activities for the past 50 years. Your Westinghouse office is a good place to go when you have a job for electricity.

New Drive boosts rod-mill output and quality



This Westinghouse equipment produced the outstanding results. At left are drive motors; in center the M-G sets which supply them power. At far right the d-c switchgear, and in foreground the Rototrol regulator and M-G set exciter.

Here's a new rod mill that produces a high output of quality steel by eliminating the rod "squeeze and stretch" problem. Basic secret: an advanced Westinghouse electronically-controlled drive that maintains roll speed with hairline accuracy.

Precisely maintains roll speed

When a billet-end enters or leaves a roll-stand, the speed of the driving motor stays constant—*despite the change in motor load.* Thus, there's no danger of the steel stretching or looping between stands which can cause distortions that no amount of subsequent rolling can completely eliminate.

More production in less space

The precise speed control of the Westinghouse drive permits the mill to run as fast as 3,900 fpm—even though the roll-stands are spaced at only 92″ intervals. This makes a neat, compact layout that turns out high production in a small amount of space. The drive has an over-all speed range of 4 to 1 so that a wide range of sizes and types can be processed.

Needs practically no attention

Once set, the drive runs for an entire shift with practically no attention from the operator. It's easy to maintain, too. Motors, M-G sets, exciters, controls, etc., are of well-known Westinghouse construction. The electronic speed regulator is built in sectional subassemblies for easy maintenance.

Call Westinghouse early on every job

Your next job can benefit from the years of steel mill experience that Westinghouse brings to every steel mill project. It pays to call Westinghouse early on *every* job. Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania. J-94882

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make every move count!

....to serve you better

with

Northern

Overhead Traveling CRANES and HOISTS

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During the past fifty years NORTHERN OVERHEAD ELECTRIC TRAVELING CRANES have been installed in many warehouses where they are providing fast, continuous, uninterrupted service — meeting peak load demands—dependably responding to rugged overloading in emergencies—making every move count for better service to suppliers and their customers.

Write for Bulletin 150-C

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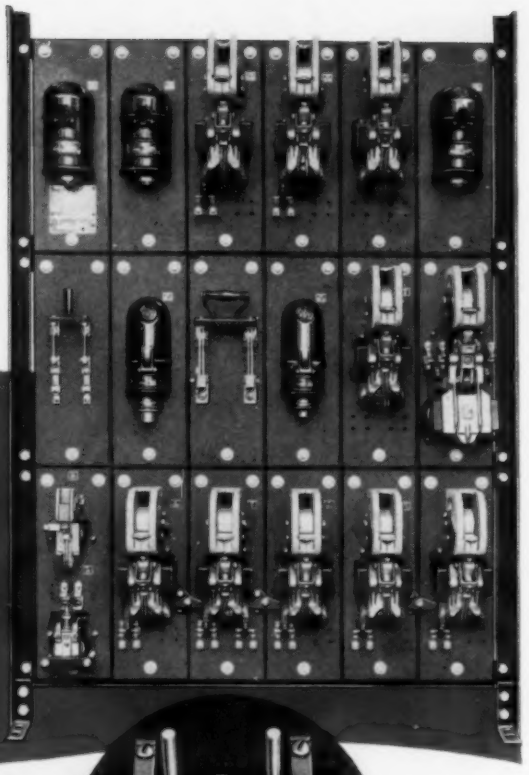
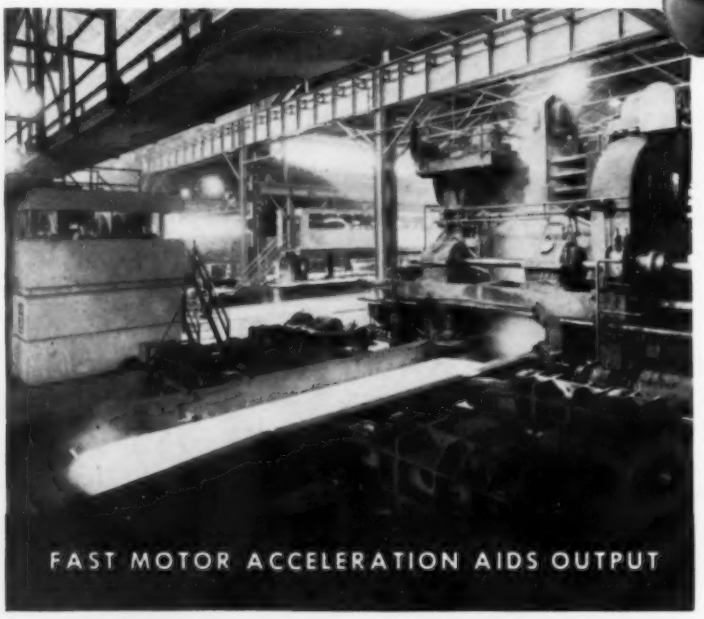


TIME-CURRENT *Acceleration*

- SPEEDS MOVEMENTS
- SAVES MOTORS

Only one moving part in the TIME-CURRENT acceleration relay—magnetically centered in its short movement.



FAST MOTOR ACCELERATION AIDS OUTPUT

An exclusive characteristic of the *Time-Current* Acceleration Relay is its ability to vary the time-per-step by self-adjustment. When stiff grease on cold mornings increases the load, these relays automatically provide longer time to enable the motors to get under way without tripping the overload relays. As the mill warms up, these relays shorten the time — speed up motor acceleration until production is normal. This self-timing feature is unequalled in any other system of acceleration.

Note, too, the dependable construction of these relays—only one moving part—magnetically centered—no wear to alter the adjustment—in fact, many hundreds of these EC&M relays are successfully operating with their original (factory set) adjustment unchanged. Specify EC&M *Time-Current* Control.

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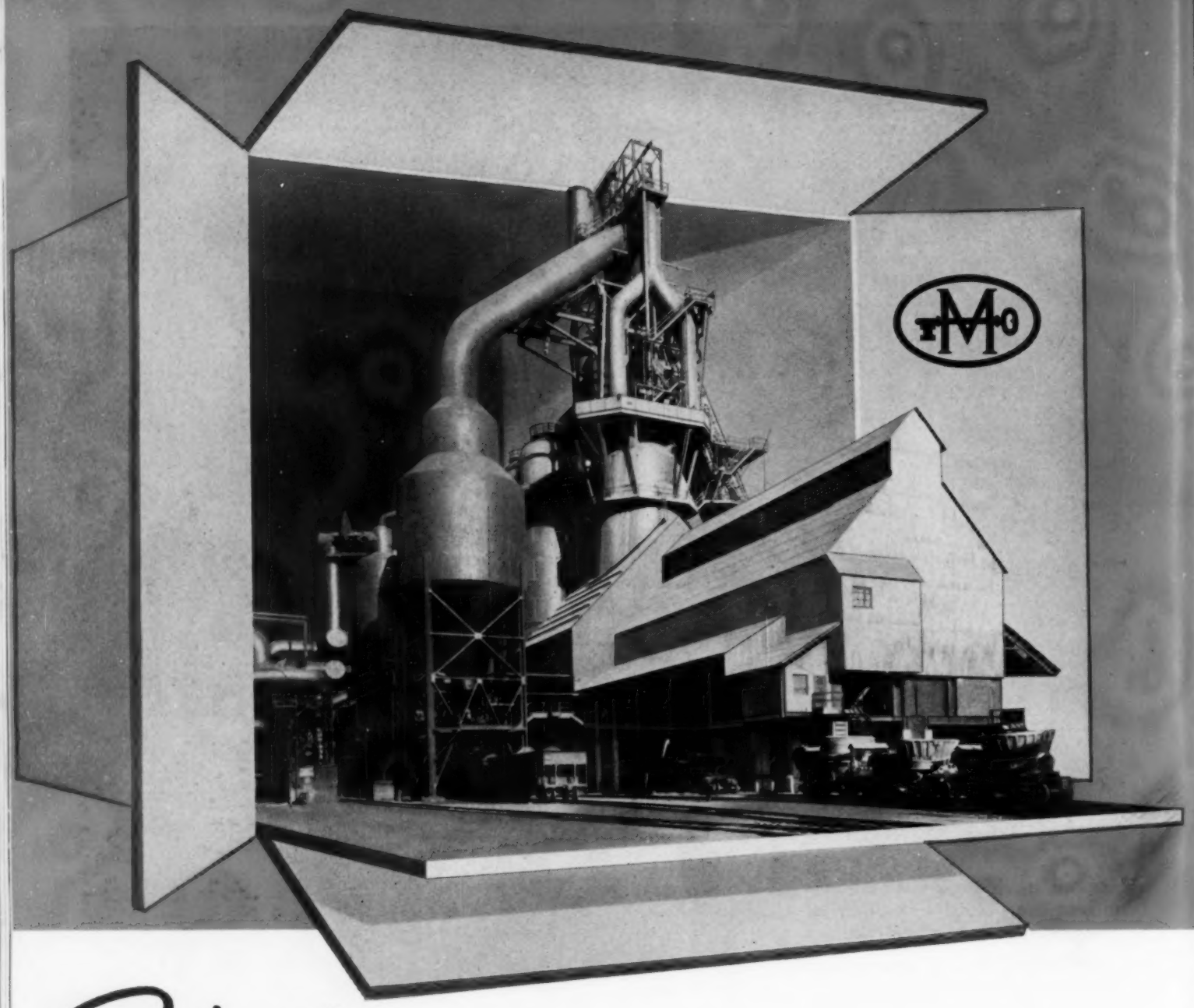

Production is up

ON NEW "TOOLS" FOR MAKING IRON AND STEEL

McKEE is designing and building new blast furnaces, steel plants, open-hearth shops, sintering plants and related facilities in many locations. The Iron and Steel Division of this organization will continue to devote every effort toward keeping pace with the Iron and Steel Industry's expansion program.

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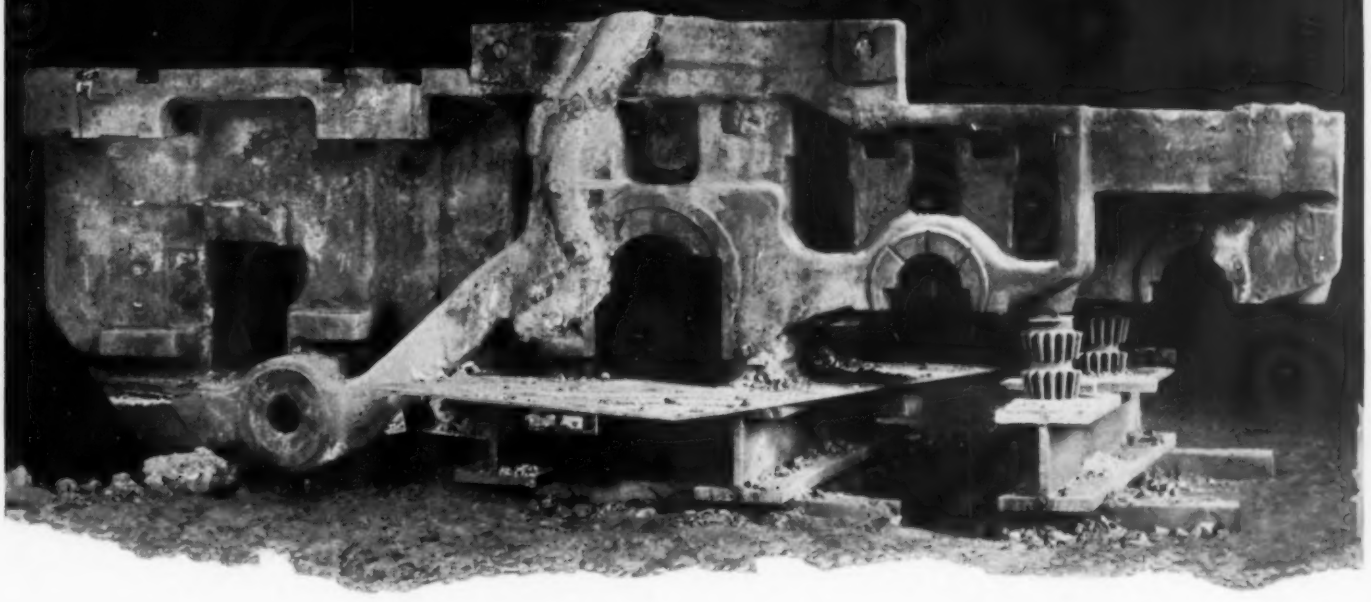
McKee *Engineering*

Arthur G. McKee & Company • Established 1905

Headquarters: McKee Building, 2300 Chester Avenue, Cleveland 1, Ohio. *New York:* 30 Rockefeller Plaza, New York 20, N.Y. *Tulsa:* 918 First National Bank Building, Tulsa 3, Okla. *England:* The Iron and Steel Division of Arthur G. McKee & Company, is represented by Head, Wrightson & Co., Ltd.

THERMIT

repairs a shear housing and breaks a production bottleneck



Shortly before this big blooming mill shear housing went down its owners, realizing the equipment was operating on borrowed time, contemplated replacement. Unfortunately the housing cracked wide open before the order was placed and important production was threatened.

Here, as in so many like cases, an emergency was met speedily at a fraction of replacement cost by means of Thermit repair. New equipment is carrying the load now but throughout the old housing's remaining term of service Thermit welds held fast and showed no signs of weakening.

Investigate! Steel mill maintenance jobs are done more easily, more quickly and at lower cost by welding with Thermit. Write for complete information.

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IRON, ALLOY IRON and STEEL ROLLS for ferrous and non-ferrous rolling mills; pulp and paper industry; textile industry; and milling, cereal and vegetable oil industries.

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Ingot Car with Operating Cab

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Ingot
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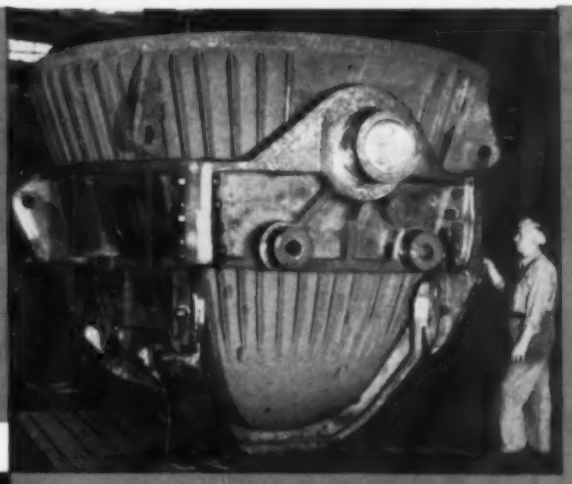
STEEL CASTINGS

20 TO 250,000 POUNDS



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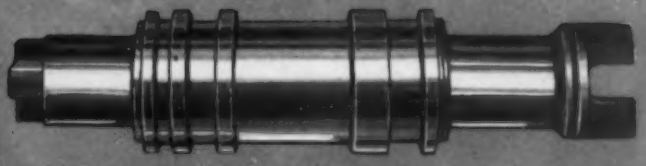
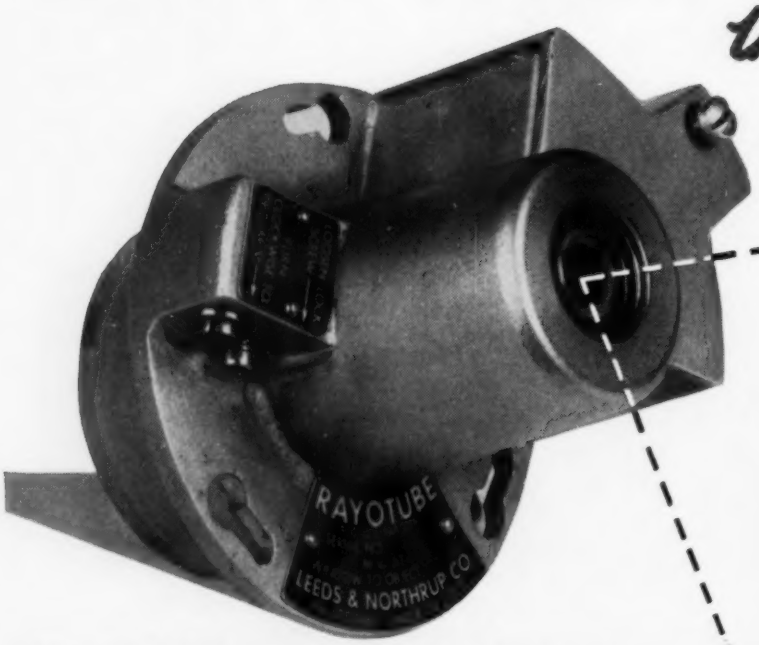
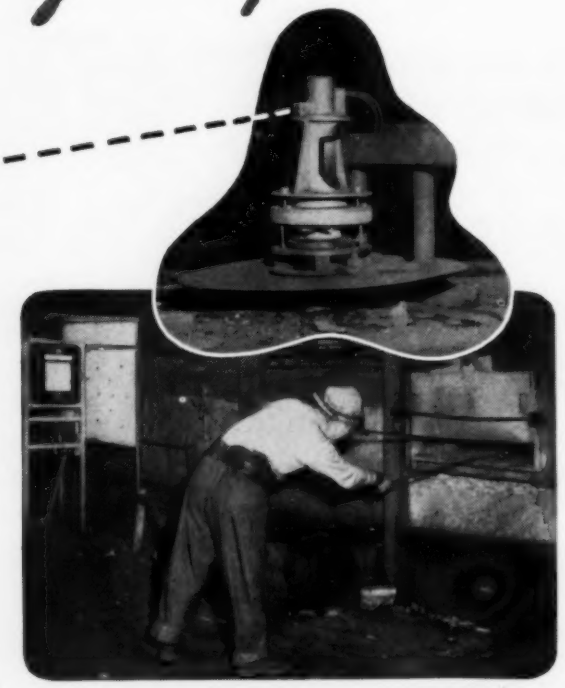


ROLLS

IRON, ALLOY IRON AND STEEL

Can this new Rayotube mean better control of temperature in your plant?





In Henry Disston & Sons, Inc. plant, Rayotube in slab furnace roof needs no water-jacket against high ambient heat.

BUILT to detect temperatures for either Speedomax or Micromax Controllers, this new Rayotube No. 8890 has three features which help to improve the accuracy of control action.

1. The water jacket often needed for earlier Rayotubes is seldom required for this one because accuracy is not affected by ambient temperatures unless the head housing itself (shown above) exceeds 350 F. Omitting the jacket greatly simplifies installation and saves both water and maintenance due to water lines.

2. Overheating the Rayotube head to as high as 500 F does no harm; the accuracy decreases above 350, but returns fully as temperature drops. Thus, a few minutes' glare from an open furnace door does not affect the instrument's usefulness.

3. New, quick-sighting optical system for aiming the Rayotube at area of important temperature is especially helpful when aiming down an open-end tube to measure directly the surface temperature of parts being heated.

Catalog N-33B describes all Rayotubes as well as Speedomax and Micromax Pyrometers; we also can send description of this Rayotube only. Kindly address either our nearest office, or 4942 Stenton Avenue, Philadelphia 44, Pa.

In spite of high ambient temperature, this Rayotube in roof of an open-hearth furnace has neither water-jacket nor air connection.

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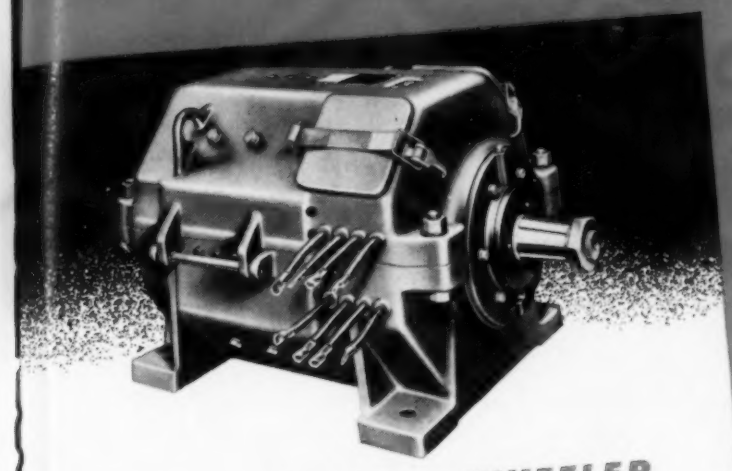
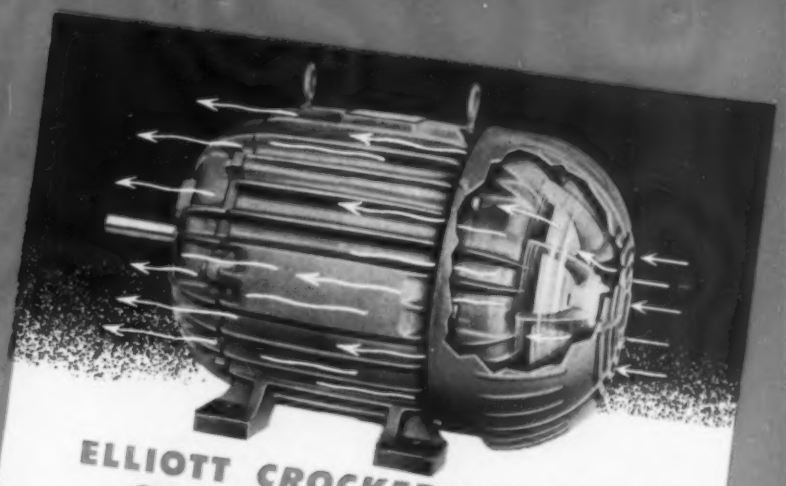


ELLIOTT CROCKER-WHEELER
600 Series MILL MOTOR

■ As sturdy and reliable as it looks, and packing as much as 33-1/3% more power in each standard size frame. For heavy duty mill and crane service in 5 to 265 hp. Also available in the following modified forms: separately forced ventilated—protected self-ventilated —back geared. Write for the Mill Motor Bulletin.



ELLIOTT CROCKER-WHEELER
SEALEDPOWER MOTOR

■ A T.E.F.C. induction motor that both cools and cleans itself by a constant stream of fan-driven air directed along the outside of the finned case. Reliability amply proved by ten years of successful applications under most trying conditions. In 3 to 125 hp. Also available in vertical type, and in explosion-proof underwriter's approved, 20 to 125 hp. Ask for the Sealedpower Bulletin.

TOUGH MOTORS FOR TOUGH JOBS!

ELLIOTT CROCKER-WHEELER
BRAKE MOTOR

■ The C-W disc brake is exceptionally compact, requiring a minimum of bulk with relation to its stopping power. Brake linings are of bonded metal, unaffected by temperature, dampness, salt water, fungi, grease or oil. Powerful springs, compressed by magnets, are released the instant power is shut off the motor, and force the heavy armature plate against the discs. Spring pressure can be adjusted by screws from the outside of the case. The brake is shown above mounted on the SEALEDPOWER motor, providing a compact, eminently reliable and enduring unit. Write for the Brake Motor Bulletin.

...Three ELLIOTT CROCKER-WHEELER Motors

designed for high performance under particularly rugged conditions!

Crocker-Wheeler motors range from 1 to 200 hp. Larger Elliott motors and generators are built by the Ridgway Division of Elliott Company in Ridgway, Pa.

HALF CENTURY OF POWER PROGRESS 1901 1951

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Crocker-Wheeler Division
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For bulletins write advertising department, Jeannette, Pa.

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CW-33

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TRANSFORMERS
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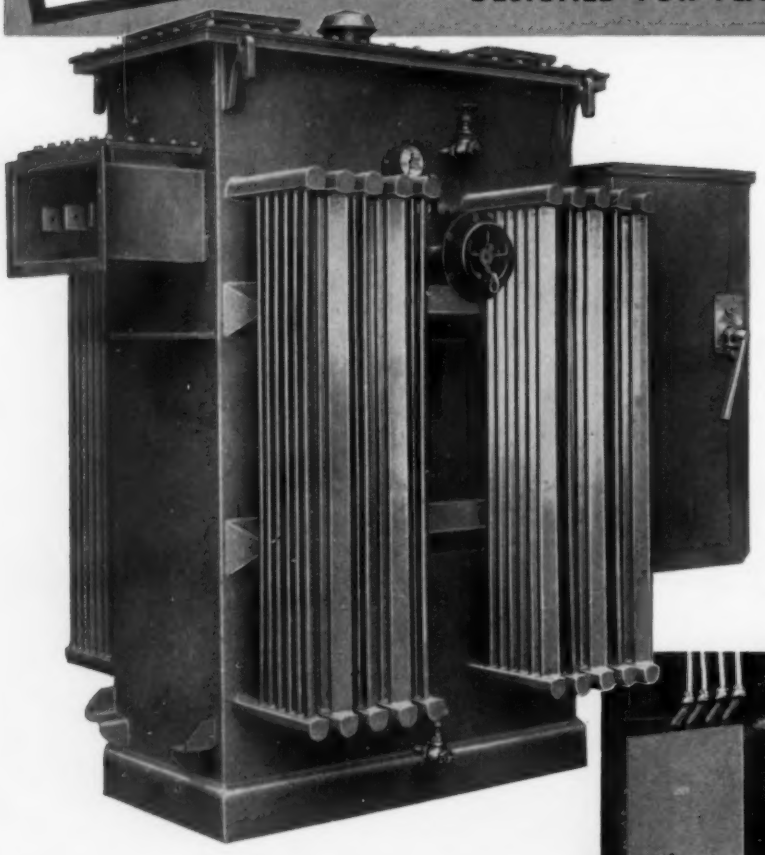
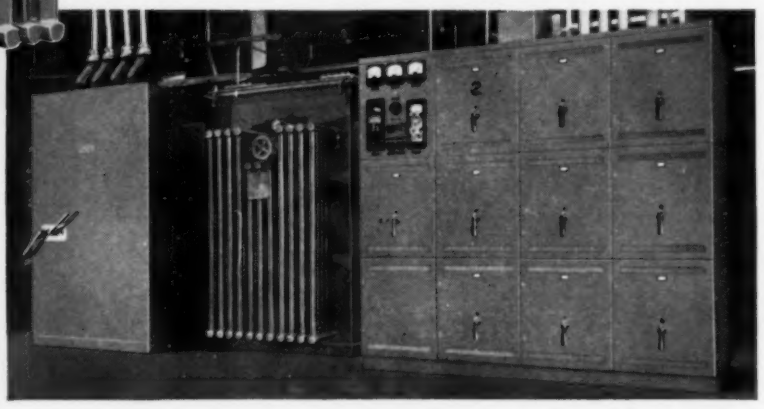
DESIGNED FOR PLANT POWER DISTRIBUTION SYSTEMS

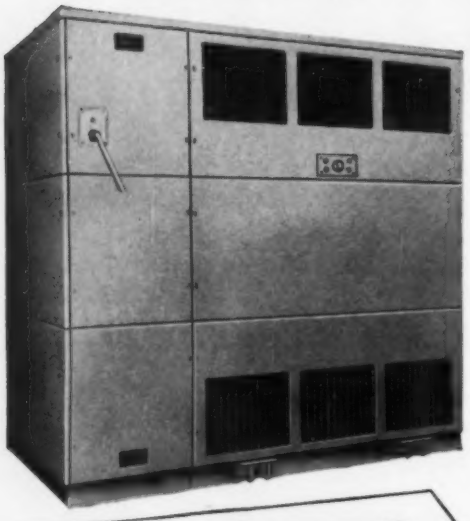


The ever-increasing demand for electric energy to power today's stepped-up production presents a critical problem. The answer to this problem has been found in load-center power distribution systems. The vital part of the load-center system is the transformer. If a switch or circuit breaker fails, only a part of the system is affected—but if the transformer fails, the entire system is dead.

Wagner Unit Substation Transformers assure a continuous, dependable flow of power. They are carefully designed to meet your distribution requirements, and are available with various types of entrances and controls for the high-voltage circuits, and with proper throats on the secondary side to connect to any make of switchgear, in the usual range of ratings up to 2000 kva.



Wagner-equipped unit substation in a synthetic textile plant.



Dry-Type Indoor Transformers

Wagner now furnishes three-phase dry-type transformers in ratings up to 2000 kva in the 15 kv class and below. These units are compactly housed in neat, attractive enclosures, which can be arranged to include primary and secondary switchgear compartments to form readily accessible, closely-coupled unit substations. Relatively light in weight, so that they can be used in multi-story buildings, they are readily adaptable to any installation requirement.

Wagner Electric Corporation
1891 WE 1951

WAGNER ELECTRIC CORPORATION
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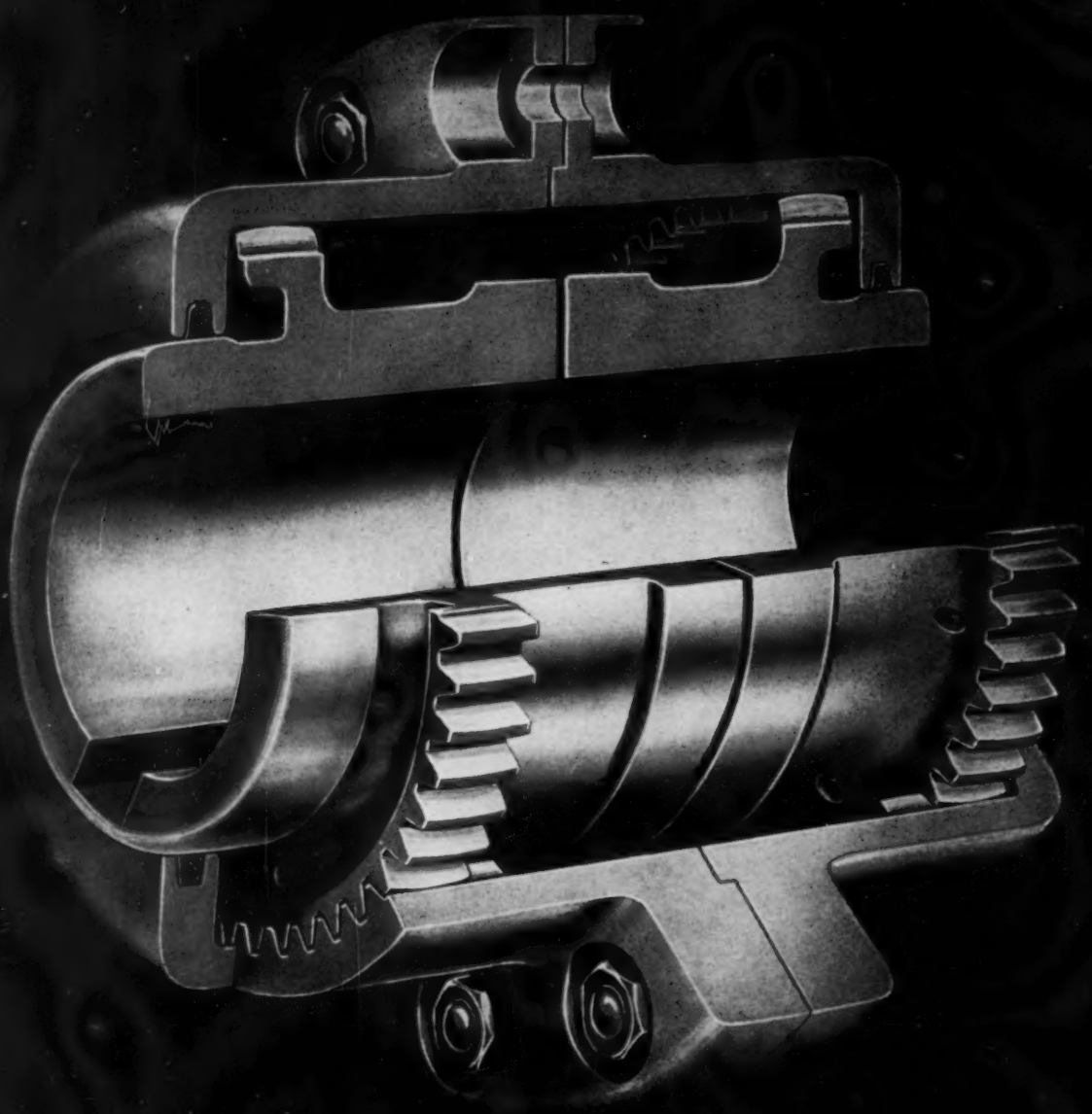
POOLE



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Publication Service...

The Complete Service Offering You Without Cost or Obligation Latest Technical Literature Compiled Especially for Steel Plant Operating Executives

(1) "Quick Facts" on Handling

A four-step approach to the job of obtaining improved handling efficiency is presented in "Quick Facts on Handling." The four-step plan is brief, but the many factors which must be considered in effectively approaching handling problems are emphasized. Also stressed are the "extra dividends" to be achieved from modernized handling such as faster production, improved safety and greater productivity of manpower. Products featured include the "Trackmobile," "Trambeam" overhead handling systems, electric chain hoists, overhead and economy type cranes, with a final word on Whiting facilities and engineering. Whiting Corp.

(2) High Temperature Insulation

A new folder that completely describes "Therm-O-Flake" high temperature insulation products has just been issued. This folder gives information on insulation block, coating, granules, concrete and brick. The insulation and refractories are used for open hearth, blast, annealing and slab reheating furnaces, soaking pits and coke ovens. Illinois Clay Products Co.

(3) Water Treatment

Just published is a 16-page booklet on water treatment and water conditioning. The booklet gives considerable technical data and describes services, products and methods employed in solving many industrial water problems. Water treatment service is divided into the following seven categories: 1) boiler water treatments, 2) water line treatments, 3) cooling water system treatments, 4) brine system treatments, 5) waste water treatments, 6) Zeolite softener treatments, 7) consulting service. Brooks Chemicals, Inc.

(4) Block Insulation

A new four-page folder on "Superex" block insulation is available. This widely-used high temperature insulation is described as the standard of industry for over 25 years. Included in the folder are the economic advantages of "Superex", and the outstanding properties of this insulation. This information is backed up with conductivity and heat loss graphs, as well as a recommended thickness table. The back cover shows a few of the many special shapes in which the insulation can be furnished. Johns-Manville.

(5) Liquefied Gases

A new booklet is available summarizing recent work with the production, handling and storage of liquefied gases. Included in the booklet are brief descriptions of the Collins helium "Cryostat," hydrogen liquefier, liquid oxygen generator, helium refrigerator and liquid-oxygen pump—all applicable to work with liquefied gases or to low temperature investigations. Also shown are the non-contaminating gas holder, air cooler (for cooling electronic gear) and a high flux density electromagnet. All of the equipment shown is now available. Much of the equipment shown stems from new or recent developments, and is not commercially available elsewhere. Arthur D. Little, Inc.

(6) Electric Oil Heaters

A new catalog describes electric oil heaters for efficiently heating heavy grades of fuel oil with automatic control of oil temperature. The heaters frequently eliminate the need of long steam and condensate line extensions or new steam generating installations where steam is not available for heating oil. With the suction type heater, the heavy oil is easily heated and maintained at the proper pumping temperature. The preheater then heats the oil from pumping temperature to the higher temperature usually required at the burner for good atomization and combustion of oil. (709). Hauck Manufacturing Co.

(7) End Seals for Cables

A bulletin is available describing an inexpensive moisture seal for terminating multi-conductor sheathed cables. Cone-shaped to receive filling compound, this device is easily and quickly slipped over the cable and eliminates the friction tape or makeshift windings which have always proved unsatisfactory and unsightly for such terminations. Methods normally used do not provide adequate protection for the individual conductors at the sheath termination and are seldom waterproof. As a result, when moisture lodges around the conductors under the sheath, premature deterioration of the cable occurs. Applicable to cable diameters of from 3/4 in. to 2 in., the Okonite end seal snugly fits over the cable sheath, preventing compound leakage. The compound hardens to form a neat, permanent, moisture-proof seal and keeps the conductors properly spaced. (OK-2091). Okonite Co.

(8) Buyer's Guide

A 93-page brochure supplying pertinent buying information on instrument transformers, has been announced as available. The publication is divided into sections which offer technical data on indoor and outdoor potential transformers, current transformers, metering outfits, potential and current portable transformers. Listings of ratio and phase-angle tests, coupled with tables covering the mechanical and thermal limits of current transformers, round out the balance of the brochure. (GEA-4626). General Electric Co.

(9) Steel Bath Temperature Measurement

To show how steelmakers are accurately and dependably measuring bath temperature in installations ranging in size from a 275-ton open-hearth furnace down to a 1000-lb high-frequency induction furnace, Leeds & Northrup has just published an illustrated, 8-page folder presenting both immersion thermocouple and immersion Rayotube equipment for molten steel temperature measurement. (N-33-640(1)). Leeds and Northrup Co.

(10) Molybdenum Disulfide as a Lubricant

As a producer of molybdenum disulfide for purposes of lubrication Climax Molybdenum has prepared a booklet entitled "Molybdenum Disulfide as a Lubricant." This publication will be sent to readers interested in lubricants and anti-fretting materials. Climax Molybdenum Co.

(11) Large Induction Motors

The large, polyphase induction motor, and where it fits into the industrial picture, is the subject of a new 28-page booklet available to you. The booklet presents a quick summary of the types and features of the two basic kinds of induction motors—Type CSF squirrel-cage motors for constant-speed drive, and Type CWF wound-rotor motors for adjustable-speed drive. Both types are available in a wide variety of open drip-proof and special enclosures, as illustrated in the booklet. (B-4739). Westinghouse Electric Corp.

(12) Electric Water Conditioner

Literature is available describing the Aqua electric scale control, designed to effect reduction and prevention of hard scale formation in boilers, heat exchangers, air conditioning systems, evaporative coolers and other equipment using or cooled with water. By passing water through an electrical field of the proper intensity the colloidal particles and dissolved salts act as a conducting medium, picking up an electrical charge adjusted in proportion to the electrical conductivity of the water itself. Through this purely physical action the particles in the water are no longer attracted to and do not build up on the tubes, castings, and other metal surfaces with which they come in contact. It is used with 110 volt 60 cycle a-c line. Aqua Electric Scale Control, Inc.

(13) Furnace and Oven Controls

A condensed catalog of furnace and oven controls, has recently been published. The 28-page catalog lists and prices a variety of instruments such as temperature controllers, recorders and indicators, electric and pneumatic operated control valves, relays, control motors, safety control equipment, generally used in the temperature control of ovens and furnaces. (51-1). Minneapolis-Honeywell Regulator Co. Industrial Division.

(14) Masonry Cutting

Practical, illustrated instructions on how to figure blade costs in masonry cutting before starting full cutting operations are contained in a new booklet "How to Cut Blade Costs in Masonry Cutting." Eveready BrikSaw Co.

(15) Valve Catalog

A new 44 page, illustrated catalog describing a complete line of valves is now available. Hundreds of standard models and modifications are described, including straightway, three-way, four-way and four-way five port units in various sizes of hand, foot, solenoid, pilot, remote control, cam, speed control, shut-off, quick exhaust and miscellaneous valves. Detailed descriptions are given together with sectional views, installation data, and diagrams. Ross Operating Valve Co.

(16) Continuous Viscosity Measurement

A new catalog now ready for distribution describes "Viscorator" instruments that provide an instantaneous method for deter-

mining viscosity values for industrial processes. Featured is a new development in this field represented by the "Auto-Sampling Viscorator" instrument which has a constant differential pressure regulator as an integral part of its design. This provides a constant meter sample flow rate (regardless of line fluctuations) in a simple self-contained unit. (88). Fischer & Porter Co.

(17) Stripper and Soaking Pit Cranes

A catalog is available describing Demag stripper cranes and soaking pit cranes for steel mill services. These are heavy-duty cranes manufactured in Germany. Included in the catalog are various installation illustrations showing various capacities. Also described are the auxiliary devices for stripping and soaking pit cranes. If you are interested in obtaining cranes, we suggest that you send for this catalog. (K107b). Kurt Orban Co.

(18) Industrial Battery Service

A booklet on methods of conserving and extending your essential battery power is available. It is a complete, integrated system of manuals, articles, specifications, bulletins, record cards and charts which give you information on every one of these eight points — explaining and illustrating how to choose, use, install, charge, maintain, inspect and test industrial storage batteries. Gould-National Batteries, Inc.

(19) Lubricant Consultation

A new booklet entitled, "Gulf Periodic Consultation Service," is available. This booklet tells how you can get practical help on any problem that involves a petroleum product. Through this advanced cooperative plan, Gulf makes available to you the regular counsel of one or more trained engineers — men who are skilled in every phase of petroleum science. This knowledge and experience can be applied profitably to your operating and maintenance problems. Gulf Oil Corp.

(20) Power Transmission

Four bulletins are available describing a complete line of enclosed gear drives for power transmission. Bulletin HGA describes horizontal "Hygrade," vertical "Hygrade," and vertical "Hytop." Bulletin LPB describes "Line-O-Power" drives. Bulletin MPB describes "Maxi-Power" heavy-duty helical gear drives. Bulletin GMA describes the new Foote Bros.-Louis Allis gearmotors. If you are concerned with power transmission, you should have these booklets in your technical library. Foote Bros. Gear and Machine Corp.

(21) Electrical Equipment

The "Pylet" catalog is available to you. This catalog describes heavy-duty safety switches and circuit breakers designed for safe, reliable operation and protection of portable and stationary electrical equipment, indoors and outdoors, under the most severe operating conditions. (1150). Pyle-National Co.

(22) Temperature Recorder

A bulletin is available describing a 6 point temperature recorder with single-point vigilance. This new multi-record "Dynalog" gives immediate warning of temperature drifts that you would expect only from single point recorders. All six records appear like unbroken lines. (427-1). Foxboro Co.

(23) Combustion Control

A booklet is available describing combustion control for industry. The booklet describes a highly developed flue gas analyzer which gives correct reports on any type and size of furnace. Quickly, accurately and fully it lets you know how much fuel may be going to waste, whether there are combustibles, or excess oxygen to cause troubles like scaling, and what combustion losses are due to useless heating of excess air. Corrections can then be made for added production efficiency. Cities Service Oil Co.

(24) Smoke Density Recorder

A booklet is available describing the Bailey smoke density recorder. It tells why this 24-hr recorder is not an ordinary photo-cell instrument. Instead, it detects smoke density by a Bolometer which is simply a sturdy tungsten filament and a parabolic mirror, mounted in a standard sealed beam automobile head lamp housing. (211). Bailey Meter Co.

(25) Electric Arc Furnaces

A catalog is available giving complete details on the Moore Rapid Lectromelt furnace. It tells how the sturdy top structure of these furnaces rides on massive oil bearings and how it swings aside easily and smoothly with no chatter to shake roof bricks loose. Pittsburgh Lectromelt Furnace Corp.

(26) Maintenance Tools

A 64-page catalog is available describing Martindale maintenance equipment. This equipment is designed for commutator and motor maintenance. Martindale Electric Co.

(27) Pump Bulletin

A new bulletin of GS pumps is available. The booklet tells how these new pumps are designed so that every working part subject to wear is contained in one easily replaced rotor assembly. The booklet also describes the service and exchange plan whereby new rotor assemblies are available for immediate shipment from conveniently located stocks throughout the country. De Laval Steam Turbine Co.

(28) Magnetic Brakes and Clutches

Two bulletins are available on magnetic equipment. Bulletin 604-F describes magnetic brakes. Discussed is the positive action of Stearns magnetic disc brakes which prevent overtravel of adjusting screws. Bulletin 226 describes a magnetic clutch. It tells how these screwdown drives are synchronized with Stearns magnetic clutch. Stearns Magnetic Manufacturing Co.

(29) Thermocouples and Pyrometer Accessories

A 56-page buyers' guide and users' manual is available to you. This new engineering handbook makes correct selection and application of pyrometer supplies an easy matter. It lists the widest variety of thermocouple assemblies, pyrometer tubes, terminal heads, thermocouple wire and extension wire on the market. Bristol Co.

(30) Instruments and Controls

Two bulletins are available on instruments and controls for two types of furnaces. Bulletin 49-750 describes a complete summary of Hays products applicable to processes such as annealing, brazing and calorizing. Scope includes various methods of firing (underfired, overfired, sidefired), fuel burned (gas, coal, oil), and type of furnace (continuous, rotary hearth, slab heating, etc.). Bulletin 49-605 summarizes applications of Hays centralized combustion control to chain grate, underfeed, spreader type, or lever type stokers. Hays Corp.

(31) "Mixed" Steel

A free sample of a Markal "Paintstik" is available for marking of hot steel. Why stall production with bad identification ("Mixed" steel) when you get positive, permanent markings with these "Paintstiks?" The marking "Paintstik" sample which will be sent to you is for the marking of hot castings, coils, plates, stickers and many other types of hot products up to 2000 F. Markal Co.

(32) Rolling Mill Lubrication

An excellent booklet is available describing efficient lubricating methods for hot and cold rolling mills and accessory machinery for steel mills. This booklet was published by E. W. Bliss Co. with the assistance of Socony-Vacuum Oil Co., Inc. The advantages and limitations of circulating oil systems, centralized pressure greasing and manual lubrication are included. Of special interest to maintenance personnel is a chart of specific recommendations for the lubrication of all mill components. E. W. Bliss Co.

(33) Power Plant Equipment

A bulletin has just been issued reviewing equipment for power plants and industry. This book describes briefly the major steam and electrical products of the five Elliott plants. Material is organized into sections, one covering steam and related equipment (turbines, centrifugal blowers, condensers, heaters, tube cleaners, etc.), the other is devoted to rotating electrical equipment (motors, generators, motor-generator sets, etc.). (Q-14). Elliott Co.

(34) Precision Milling and Grinding

A bulletin is available describing "Versa-Mil," which can be combined with machine tools or work-holding fixtures for use in production machining and in maintenance and experimental shops. The booklet describes the wide range of speeds and angular positioning. Detailed descriptions with specifications and performance data are included. (8). Versa-Mil Co.

(35) Super-Refractory Cements

A folder is available describing "Sillimanite" super-refractory cements. The catalog covers slag resistance, workability, the types of cements available, heat-setting vs air-setting cements, the importance of low shrinkage, "Tasil" cements for the steel industry, "Tasil" in the blast furnace. Included in this catalog is a guide to the selection and use of super-refractory cements. (314). Chas. Taylor Sons Co.

(36) Engineering, Design and Construction

Two bulletins are available on the subject of engineering, design and construction. The first is entitled, "Engineering Consultation, Design, and Construction for Industry," and the second is entitled, "The Inside Story of Outside Help on Call for the Needs of Industry." Both of these booklets tell the complete story of a large

engineering and construction company's services. Ebasco Services, Inc.

(37) Manufacture of Hydraulic Equipment

A comprehensive catalog is available showing the extent of operations of one company in the manufacture of hydraulic presses, valves and allied equipment. This booklet covers the manufacture of this type of equipment from the pattern shop to the shipping of finished product. R. D. Wood Co.

(38) Hydraulic Duplicating Attachments

A catalog is available describing "Turchan" hydraulic duplicating attachments for machine tools. The booklet tells how this hydraulic duplicating attachment will usually eliminate the need for purchasing additional machine tools when mass production or job lot duplicating is to be done. A master pattern or template is duplicated directly and automatically in metal. This attachment can be easily attached to any standard milling machine, boring mill, lathe, shaper, planer or grinder. Turchan Follower Machine Co.

(39) Electrical Contracting

A booklet is available describing a national electrical contracting firm. The booklet tells how Detroit production methods are used in industrial building. It also tells how this firm has combined several contracting companies, in various areas, into one national organization. Harlan Electric Co.

(40) Tong Test Ammeters

A booklet is available describing tong test ammeters which give instant current measurements of alternating and direct current. It tells how this instrument measures a-c or d-c simply by encircling the conductor with the tongs and closing them. A clear, accurate reading is registered on the scale. The tongs open by a slight pressure of one finger on the trigger and are self-closing. (TT-5025). Columbia Electric Manufacturing Co.

(41) Molded Bearings

A bulletin is available describing "Lignalloy" molded bearings. These bearings will outwear non-ferrous metals as much as 10 to 20 times. The "Lignalloy" radial type bearings rate high in wear resistance and low in friction loss. This affords you increased power, and results in reduced cost per ton rolled. Water-cooled, these bearings save you cost of expensive oils and greases. Kling Brothers Engineering Works.

(42) Modern Lubricant

A book is available describing "Lubriplate," the modern lubricant. This booklet completely describes lubricating grease and fluid products. It gives recommendations for various types of plants. Under iron and steel plants it lists various types of "Lubriplate" recommendations, hot mill shear lubrication, crane lubrication, lubrication for picklers, gear lubrication, centralized grease systems and many other types of lubrication. Every lubrication engineer and maintenance superintendent should have this booklet in his file. (1-51). Lubriplate Division, Fiske Brothers Refining Co.

(43) Refractories and Insulations

A very complete booklet on refractories and insulations is available to you. The book is broken down into two parts: (1) refractory materials and (2) insulation materials. Under the first section, the various castable cements, chrome base castable cements, bonding cements — air setting, bonding cements — heat setting and ramming type refractories are described. Under the second section blocks and blankets, plastic heat insulations, fill insulations, electrical insulations and surface protective coatings are covered. Refractory and Insulation Corp.

(44) Boiler Feed Water Control

A catalog is available describing a most unusual performance report. This bulletin illustrates and describes three different types of boiler feed control systems in three power plants. Never before has the story of so many methods of control been told in a single report. One plant has three-influence control through the hydraulic couplings of the boiler feed pumps. The second plant has conventional three-influence control using a feed control valve. A third plant has two-element air-operated control. (489). Northern Equipment Division, Continental Foundry and Machine Co.

(45) Recording Meters

A new bulletin on a recently-announced line of recording voltmeters and ammeters has just been published. The bulletin describes the features of the instruments, with special emphasis on the newly-developed moving-iron measuring mechanism. Complete information is given on ranges, uses, and specifications of the various models for permanent installation and portable use. Reproductions of charts and actual chart records made by the new recording voltmeters and ammeters are included. (E1111). Bristol Co.

(46) The Yoder Way

A 68-page booklet of information on the mechanics as well as the economics of tubemaking is available to you. A description of electric weld tube mills is included in this booklet. The Yoder Co.

(47) Thread Inserts

A new bulletin is available describing design data on helical-wire thread inserts and the use of these inserts in the protection and repair of tapped holes. Detail drawings and text explain how these inserts are used as original manufacturing components to protect tapped threads against stripping, wear, corrosion, seizing and galling. (650-R). Heli-Coil Corp.

(48) Magnetic Conveyor Element

A new bulletin describes a permanent conveyor element available in three styles for conveying skelp, plate, sheet, rod, bar, pipe and shapes. Eriez Manufacturing Co.

(49) Centrifugal Pumps

A booklet is available describing and illustrating one of the broadest lines of general purpose pumps offered by any manufacturer. These "Fluidyne" pumps are of the horizontal, end-suction centrifugal type and may be driven by electric motors in sizes from ¼ to 150 hp, affording a capacity range from 10 to 5500 gpm. Liquids can be pumped against heads up to 260 ft. (B-2300). Peerless Pump Division, Food Machinery and Chemical Corp.

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60	BAILEY METER CO.	BULLETIN 230-C	Gives the full story on the Pyrotron electronic resistance thermometers.
61	BEDFORD FOUNDRY AND MACHINE CO.		Catalog available on Bedford cranes.
62	BRISTOL CO.	BULLETIN T840	Describes Bristol thermometers.
63	BROOKS OIL CO.		24-page bulletin available on "Leadolene" klingfast.
64	BROWNING AND CO., INC., VICTOR R.	BULLETIN "E"	Describes Browning mill type cranes.
65	CITIES SERVICE OIL CO.		Catalog on combustion control for industry.
66	CLEVELAND WORM AND GEAR CO.	CATALOG 300	Gives the facts on Cleveland's fan-cooled worm-gear speed reducer.
67	COLUMBIA ELECTRIC MFG. CO.		Descriptive bulletins on Columbia motor generators.
68	ELECTRIC SERVICE MFG. CO.	BULLETIN 609A	Contains full information on the "Glastic" insulator.
69	ELECTRIC STORAGE BATTERY CO.	FORM 5161	Explains in detail the Exide-Ironclad batteries.
70	ELLIOTT CO., CROCKER-WHEELER DIVISION		Describes the Elliott C-W motors.
71	FARREL-BIRMINGHAM CO., INC.		Reveals the many features of the Farrel heavy-duty roll grinder.
72	FOOTE BROS. GEAR AND MACHINE CORP.		Bulletin gives complete information on Foote Bros. "Hy-grade" enclosed worm gear drives.
73	GENERAL ELECTRIC CO.	BULLETIN GEA-5408	Gives data on G-E d-c crane drives.
74	GULF OIL CORP.		Bulletin available on "Gulf Periodic Consultation Service."
75	INDUSTRIAL GEAR MFG. CO.		Pictorial trip through the Industrial Gear plant is available.
76	JONES FOUNDRY AND MACHINE CO., W. A.	CATALOG 70	Describes herringbone speed reducers.
77	KOPPERS CO., INC., SHOPS DIVISION		Gives the facts on Fast's couplings.
78	LEEDS AND NORTHRUP CO.	CATALOG N-33B	Describes Rayotubes as well as Speedomax and Micromax pyrometers.
79	LESLIE CO.	BULLETIN 461B	Tells about pressure reducing valves.
		BULLETIN 464A	Gives details on temperature regulators.
		BULLETIN 468	Contains information on interchangeability.
80	MAGOR CAR CORP.	BULLETIN DS-102	Tells the full story of Magor air dump cars.
81	MARKAL CO.		Sample of the Markal "Paintatik."
82	NATIONAL BEARING DIVISION, AMERICAN BRAKE SHOE CO.		Bulletin available on bronze and copper bearings and castings.
83	NICKEL CADMIUM BATTERY CORP.	BULLETIN 136	Gives further data on "Nicad" batteries.
84	NORTHERN ENGINEERING WORKS	BULLETIN 150-C	Contains information on Northern overhead electric traveling cranes.
85	OAKITE PRODUCTS, INC.		24-page booklet on Oakite-developed solvent detergents.
86	OKONITE CO.	BULLETIN IS-1053	Describes Okonite wires and cables.
87	POOLE FOUNDRY AND MACHINE CO.		Catalog available on flexible couplings.
88	PYLE-NATIONAL CO.	CATALOG 2100	Gives a complete description of Pyle-National heavy-duty floodlights.
89	RELIANCE ELECTRIC AND ENGINEERING CO.	BULLETIN C-2001	Describes the manufacture of Reliance Type "T" heavy duty d-c motors.
90	TAYLOR SONS CO., CHAS.	BULLETIN 507	Describes the Tayco-40, high temperature silica cement.
91	TIDE WATER ASSOCIATED OIL CO.		Bulletin available on "Tide Water Associated Lubricania."
92	TRUFLO FAN CO.		Illustrated literature available on Truflo fans.
93	WESTINGHOUSE ELECTRIC CORP.	BOOKLET B-4730	Explains Westinghouse mill motors and controls.
94	YODER CO.		68-page book available on tube making.

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1011 EMPIRE BUILDING

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SQUARE D FIELD ENGINEERING *in Action!*

Landis Tool Precision Roll Grinder at the United Engineering & Foundry Company, Vandergrift, Pa.

PROBLEM: To design an electrical control system for a Landis Tool 60" x 192", Type 30 roll grinder with eight D.C. motors.

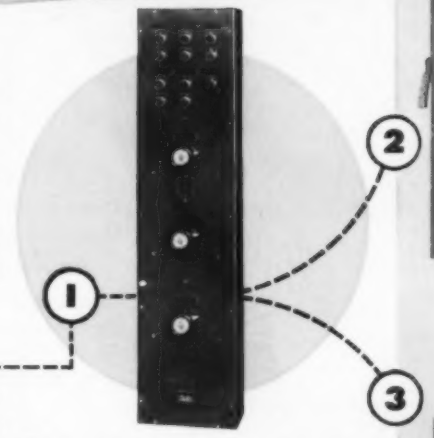
Master control station on traveling carriage to control all functions.

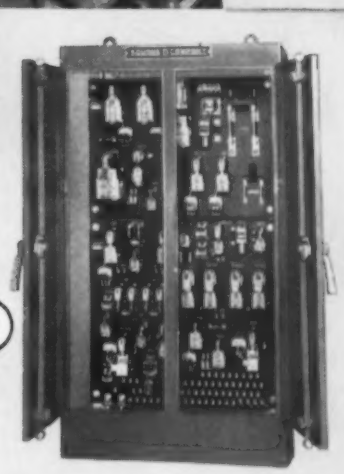
No trailing cables between floor and carriage. Minimum number of trolley wires. Rigid space limitations on carriage mounted equipment.

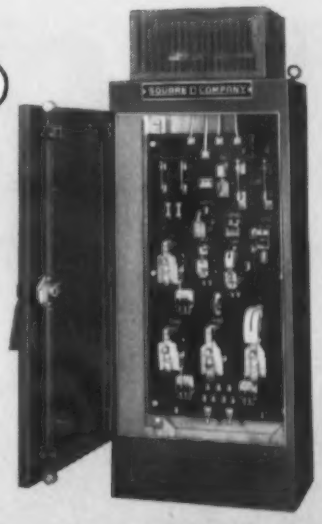
SOLUTION:

Square D Heavy Duty D.C. Control Panel and Master Control Station on carriage with interlocked, floor-mounted control panel for work drive motor.

Control circuit developed with field switching feature requiring only 1 control trolley and 2 power trolleys. (Normally 6 to 8 trolleys would be required.) *All* floor-to-carriage flexible *cables eliminated.* Space limitations met without sacrifice of electrical clearances or protective features.







1 Master Control Station, mounted on traveling carriage.

2 Carriage-mounted Controller starts, accelerates and stops these motors: wheel drive, carriage traverse, ways lubrication pump, spindle lubrication pump, wheel in and out rapid movement, coolant pump.

3 Floor-mounted Controller for starting, stopping and speed control of work drive motor.

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with every roll ground on a Farrel machine

Users of the latest type Farrel Heavy Duty Roll Grinder report that they are able to cut roll grinding time substantially.

They find the machine extremely fast for either heavy roughing or producing as high a mirror finish as it is possible to obtain with wheels at present available. Many automatic features simplify both set-up and operation. Setting-up time is held to a minimum.

Farrel machines grind straight, convex or concave rolls. The Farrel crowning device produces a mathematically accurate curve, symmetrical on both halves of the roll, for either a convex or concave shape, without manipulation by the operator. It is easily and quickly set and the same setting invariably produces exactly the same curvature and permits fixed, uniform and easily controlled accuracy of contour in all rolls.

Write for Bulletin No. 115 which describes in detail the many features of the Farrel Heavy Duty Roll Grinder. A copy of this 28-page bulletin will be sent to you without cost or obligation.

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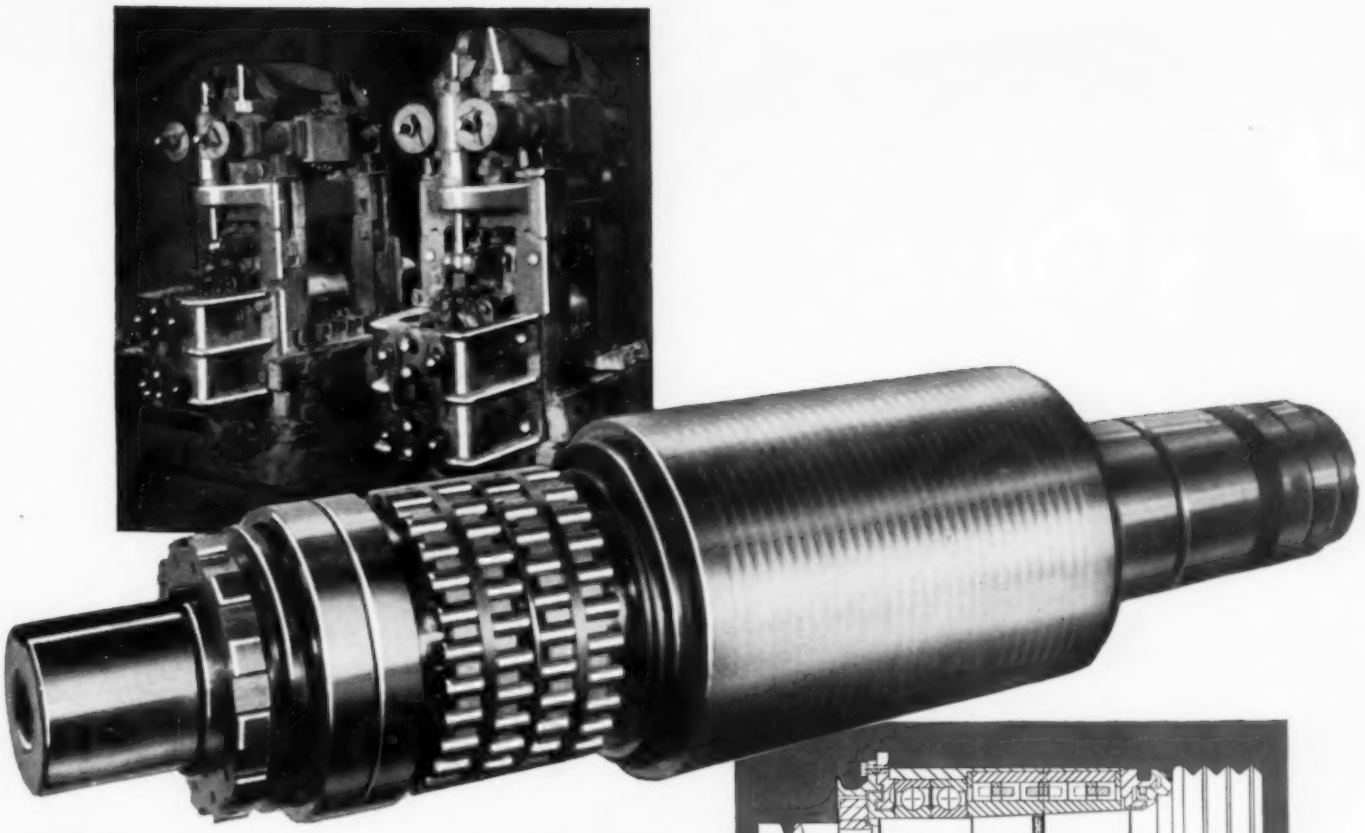
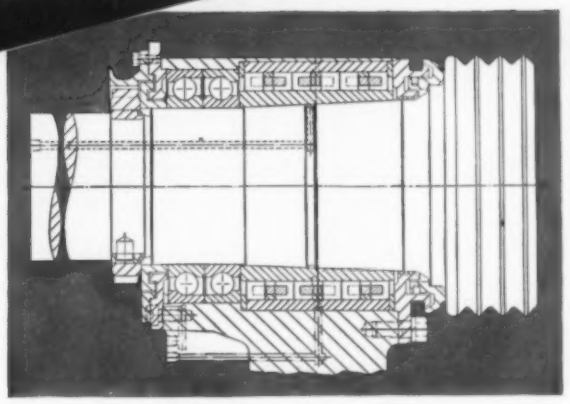


SHIFT AFTER SHIFT

new roll neck mounting increases production



Now mounted on SKF bearings, the rod mills of a prominent mid-west mill increases production, shift after shift, and rolls three strands simultaneously. The new roll neck mounting, developed by SKF, is made up of a multi-row cylindrical roller bearing that carries the rolling load and angular contact ball bearings for axial stabilization of the rolls—working as a unit. It takes only a minute to mount or dismount the bearings and chucks as a unit during roll changes—thanks to SKF's oil injection method. Continuing research, rigid adherence to high manufacturing standards and strict quality control are your assurance that SKF can help you design for greater efficiency, effective performance.

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.
—manufacturers of **SKF** *and* HESS-BRIGHT *bearings.*

7143-A

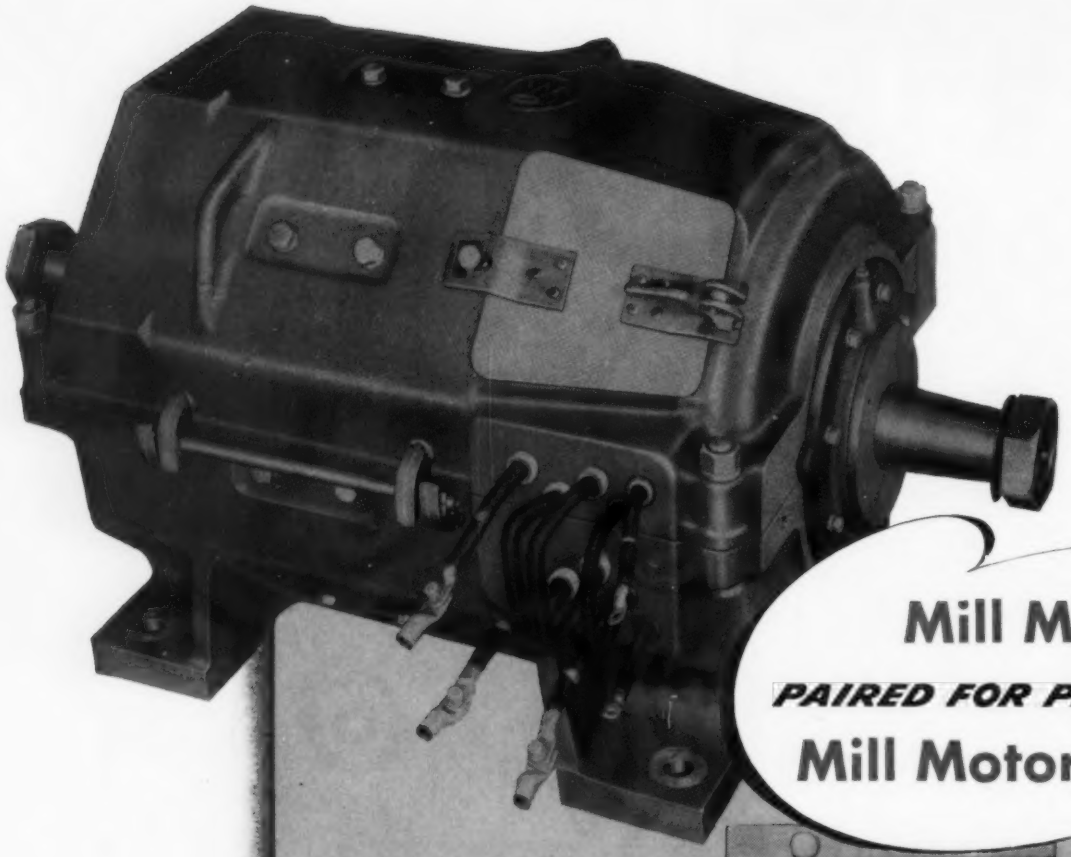
SKF

BALL AND ROLLER BEARINGS

8 REASONS WHY SKF IS PREFERRED BY ALL INDUSTRY

Integrity — Craftsmanship — Metallurgy — Tolerance Control

Surface Finish — Product Uniformity — Engineering Service — Field Service

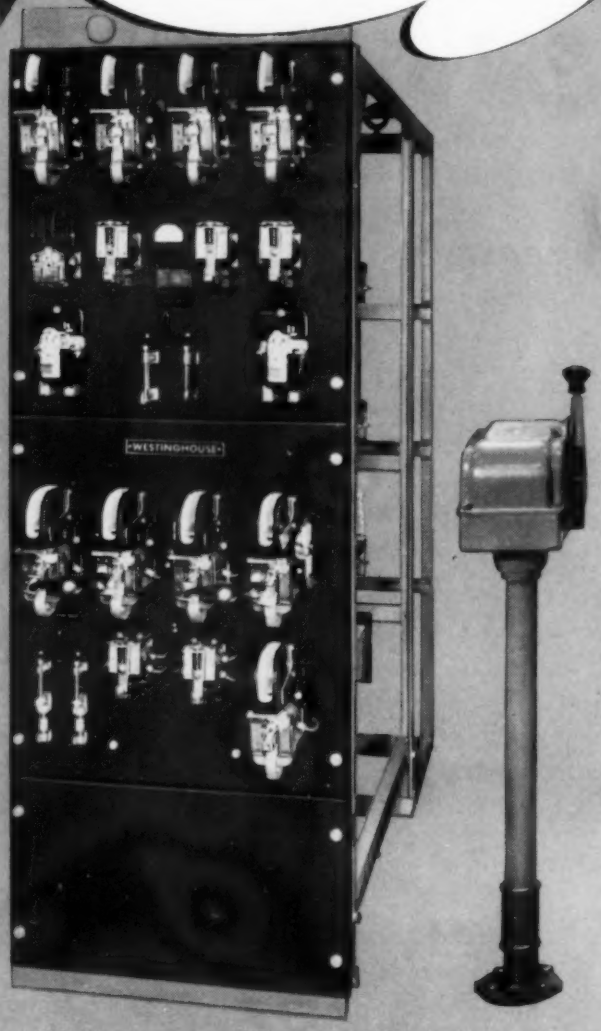


Mill Motor

PAIRED FOR PRODUCTION

Mill Motor Control

600 Series Mill Motor



Typical 9500
Line Controller, Type M
Contactors and Type SM
Master Switch

Rugged!

cut mill down time with this team

Certainly in a mill, where down time costs add up fast, the ability of equipment to stand up to rugged continuous duty is of paramount importance. That's why you'll find this combination hard to beat. They are rugged . . . made together to work together. Each incorporates the latest design features to keep production lines rolling.

Take the motor for example. The high starting torque of this new 600 series mill motor is ideal for high inertia loads . . . proved commutation . . . high rated efficiency assures maximum performance under tough service conditions . . . simplified construction makes servicing and maintenance easy. It is a brand-new motor with a new kind of performance built for today's tougher jobs.

Controllers, too, are built to assure new dependability. Main contactors are the new Type M with knife-edge, trouble-free bearings . . . with exclusive Quick-Quench arc boxes which greatly increase contact life. Overload relays are the dual thermal instantaneous type. Accelerating relays are the time-proved inductive time delay Type AZ.

The third part of this control team is the rugged Type SM master switch. Easy to operate, yet with a definite "feel" for each operating point of position, the switches are available with 2 to 6 speed control.

Together, these three offer a new kind of dependability. Get the facts on all three. Ask your nearby Westinghouse representative for a copy of the new booklet B-4730, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21647

YOU CAN BE SURE.. IF IT'S

Westinghouse

MILL MOTORS AND CONTROLS

MORGOIL
ROLL NECK BEARINGS

continue to win world-wide favor . . .

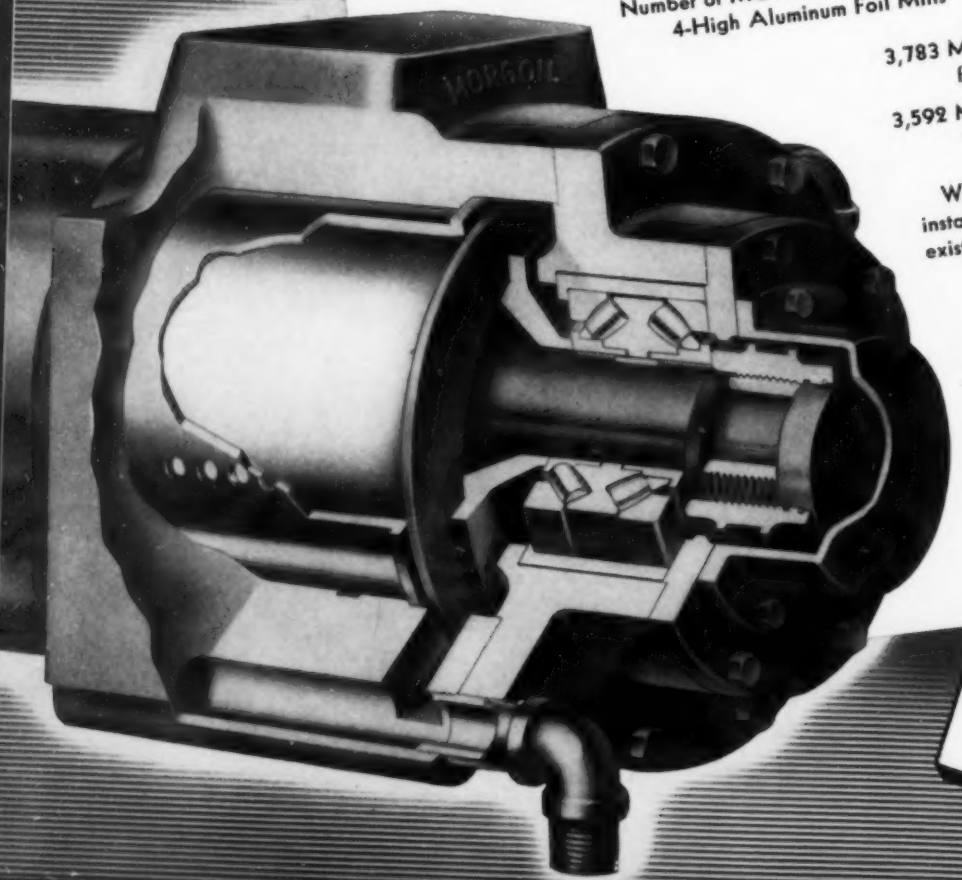
The genuine satisfaction of Morgoil users, rolling every type of metal . . . is indicated by the record of re-orders.

116 COMPANIES HAVE PURCHASED		7,375
which have been installed in 156 mills		920
The First MORGOIL Purchases by 46 Mills Rolling Steel		3,919
Subsequent Orders by these 46 Mills		6,233
TOTAL MORGOILS PURCHASED FOR STEEL MILLS		44
Eight Companies Rolling Copper and Brass First Ordered		420
Subsequent Orders by these Companies		524
TOTAL MORGOILS PURCHASED FOR COPPER AND BRASS MILLS		32
Four Companies Rolling Aluminum First Ordered		448
Subsequent Orders by these Same Companies		618
TOTAL MORGOILS PURCHASED FOR ALUMINUM MILLS		4,343
		3,032
Number of MORGOILS in Use on 2-High Mills	19	
Number of MORGOILS in Use on 4-High Mills	31	
Number of 4-High Tandem Hot Mills Using MORGOILS	7	
Number of 4-High Tandem Cold Mills Using MORGOILS	40	
Number of 4-High Reversing Hot Mills Using MORGOILS		
Number of 4-High Reversing Cold Mills Using MORGOILS		
Number of MORGOILS Used on 2-High and 4-High Aluminum Foil Mills		388

3,783 MORGOILS Have Been Purchased for use in the United States

3,592 MORGOILS Have Been Purchased for use in Foreign Countries

We would like to receive your inquiries for the installation of MORGOIL Bearings in new or existing mills of all types.



MORGAN CONSTRUCTION COMPANY

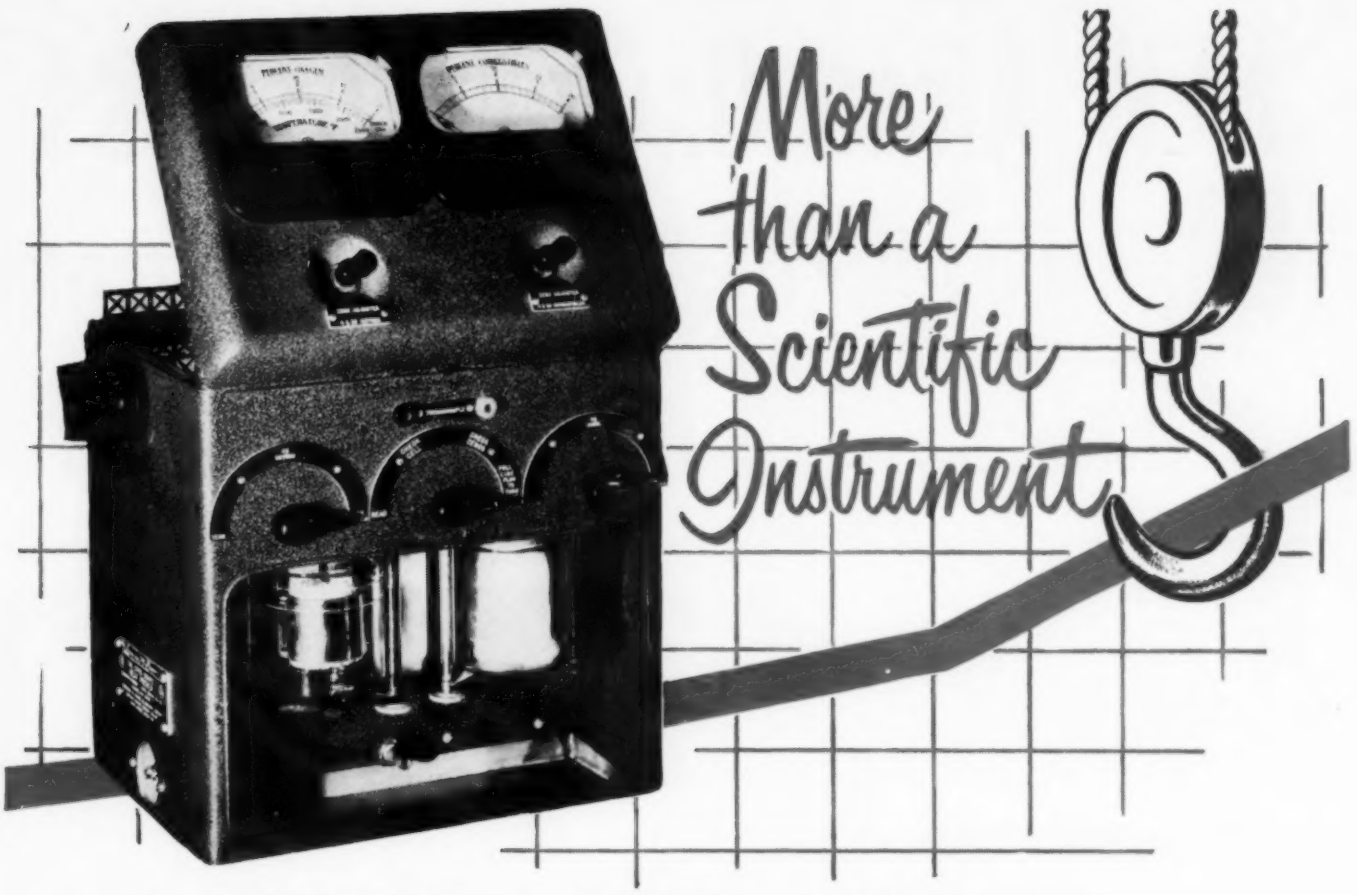
WORCESTER, MASSACHUSETTS

English Representative
International Construction Co.
56 Kingsway, London W. C. 2, England

MB-17

MORGAN WORCESTER

Rolling Mills - Wire Mills - Gas Producer Machines - Regenerative Furnace Control



A HOIST FOR YOUR PRODUCTION CURVE

Are you wasting furnace fuel? ☐

Is excess (scale-making) oxygen present? ☐

Are you paying needlessly to heat excess air? ☐

Facts that answer these vital questions are promptly supplied by the Cities Service Heat Prover. This exclusive flue gas analyzer strictly checks combustion factors. Then sources of loss can be traced and corrected. Operators of all types of furnaces report they have been able to clamp down on cost and step up production, simply by using the Cities Service Heat Prover. Find out how easily you can arrange to put it on the job. Send the coupon.

A complete line of petroleum products for the Metal Fabricating Industry including:

- ★ Chillo Cutting Oils
- ★ Trojan Greases
- ★ Trojan Gear Oils
- ★ Pacemaker Compressor Oils
- ★ Pacemaker Hydraulic Oils
- ★ Optimus Cylinder Oils
- ★ Q-T (Quenching & Tempering) Oils
- ★ Tableway Lubricants

⇩ This coupon brings complete details in your copy of "Combustion Control for Industry."

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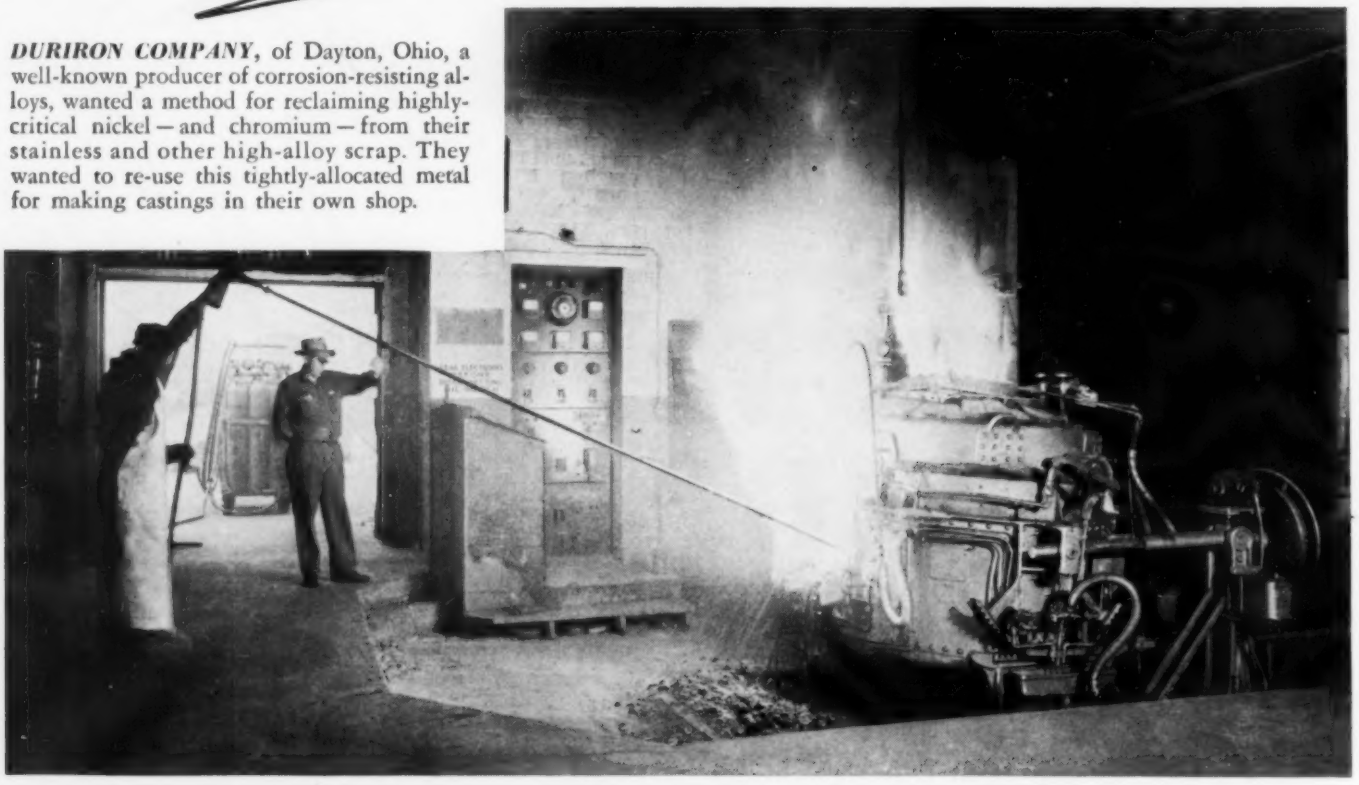
City_____ State_____

NEW Airco Oxygen Process reclaims nickel...chromium from stainless and high-alloy scrap

DURIRON COMPANY, of Dayton, Ohio, a well-known producer of corrosion-resisting alloys, wanted a method for reclaiming highly-critical nickel — and chromium — from their stainless and other high-alloy scrap. They wanted to re-use this tightly-allocated metal for making castings in their own shop.



W. T. Bryan, Duriron Co., and ***H. C. Linde,*** Airco Technical Sales Representative, working together, used oxygen refining as a means of removing carbon from the alloy steel bath. On the basis of experience, it was found that the carbon removal was accomplished without excessive oxidation of chromium from the high alloy scrap charge. Equally important, all of the nickel charged was recovered. This permitted the foundry to reclaim all scrap.

The Duriron Company was highly pleased with these results, and have adapted this process as standard practice ... and, now produce low-carbon, high-alloy castings from material that otherwise would be useless to them.

For further information about this modern method for reclaiming high-priority nickel — and chromium — from your scrap, call or write your nearby Airco office for Technical Sales assistance.

AIRCO

AIR REDUCTION

AIR REDUCTION SALES COMPANY • AIR REDUCTION MAGNOLIA COMPANY
AIR REDUCTION PACIFIC COMPANY
REPRESENTED INTERNATIONALLY BY AIRCO COMPANY INTERNATIONAL
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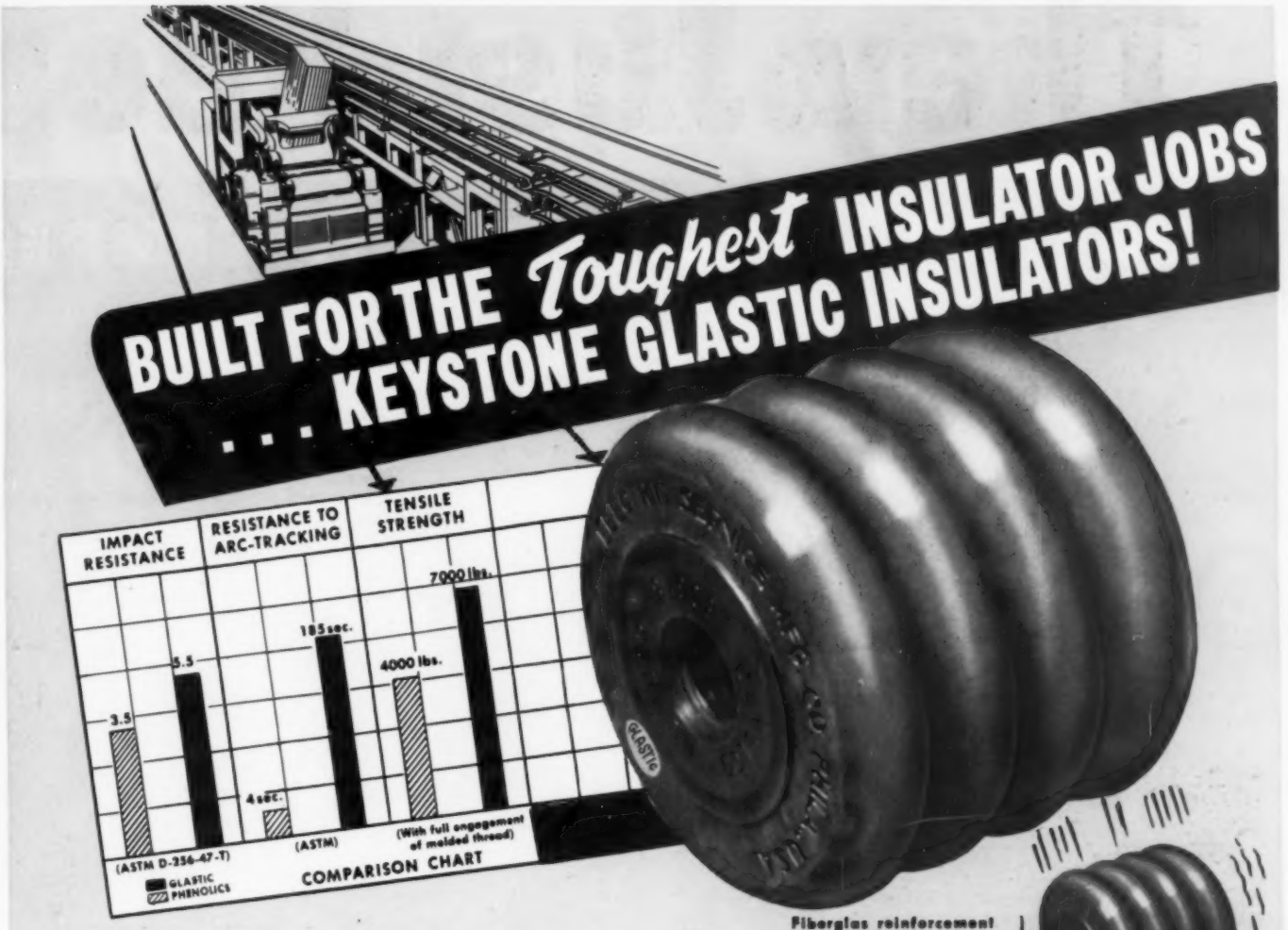
Offices in Principal Cities



BUILT FOR THE *Toughest* INSULATOR JOBS . . . KEYSTONE GLASTIC INSULATORS!

Keystone Glastic insulators are specifically designed and made for hard service use. Where ordinary insulators become brittle and break down completely under high temperatures and current overloads, Keystone Glastic insulators are unaffected.

You get many superior advantages with Glastic insulators not found in those of phenolic composition. Keystone Glastic insulators resist high heat, chemicals, rough handling, salts and moisture.

Insulators are molded around completely machined inserts with tapped threads in blind holes, all zinc-plated finish for corrosion resistance. If you are looking for insulators with outstanding properties for tough service, investigate Keystone Glastic insulators. Can be designed to meet your immediate requirements.

The Glastic insulator is one of a complete Keystone line available for use with rail, wire or angle conductors, in either over-running or under-running operation.

Write today for new bulletin 609A on the Glastic Insulator. Address Dept. I.E. 1721.

Fiberglas reinforcement gives Glastic insulators exceptional strength for impact and shock resistance, dimensional stability and rigidity.

Exceptional resistance to arc-tracking . . . 45 times better than phenolics.

Non-absorbent. Resists chemicals, most acids, salts and hydrocarbons.

Suitable for operation under maximum sustained temperatures up to 300° F.

ELECTRIC SERVICE MANUFACTURING CO.

PHILADELPHIA 32, PENNA.

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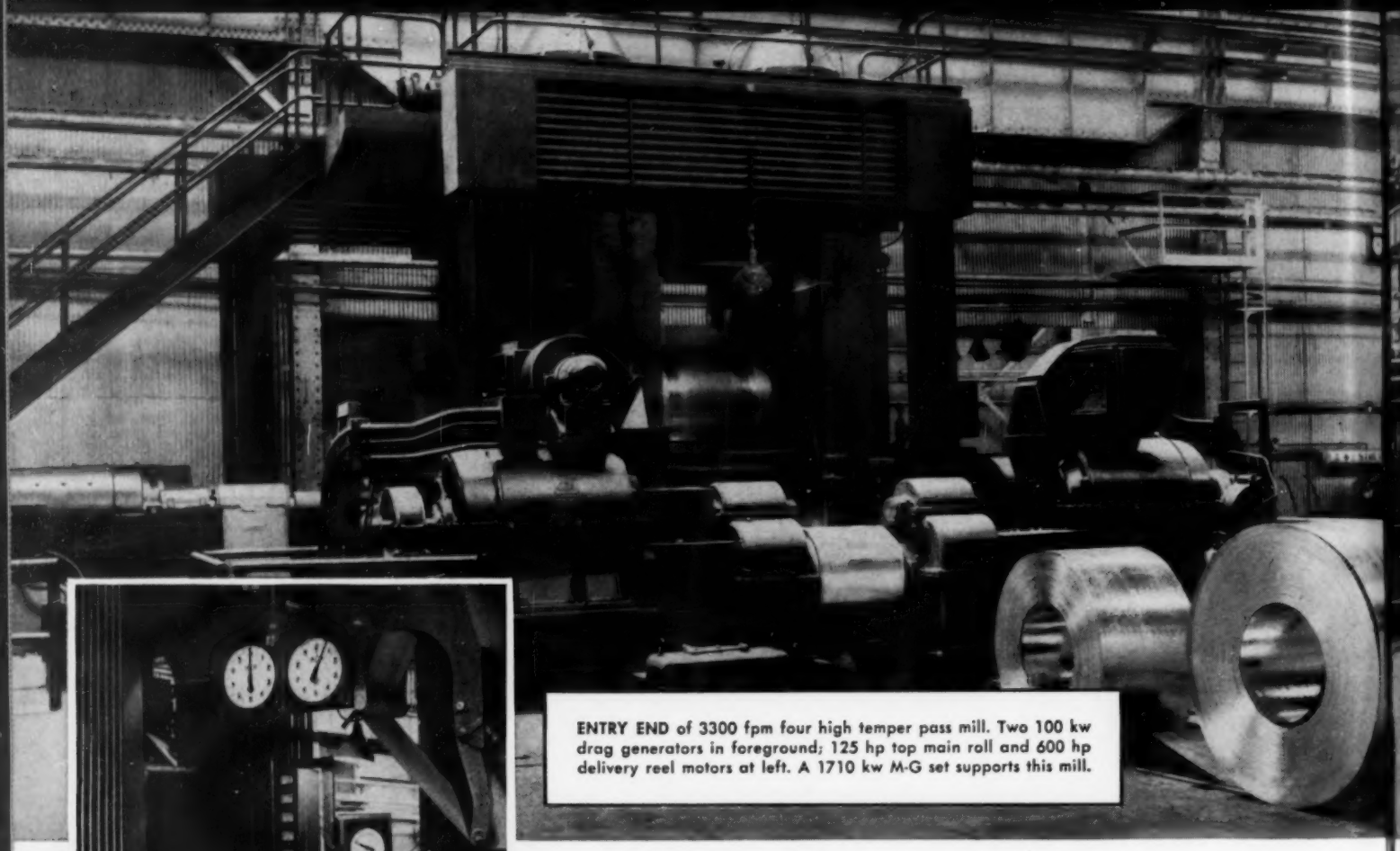
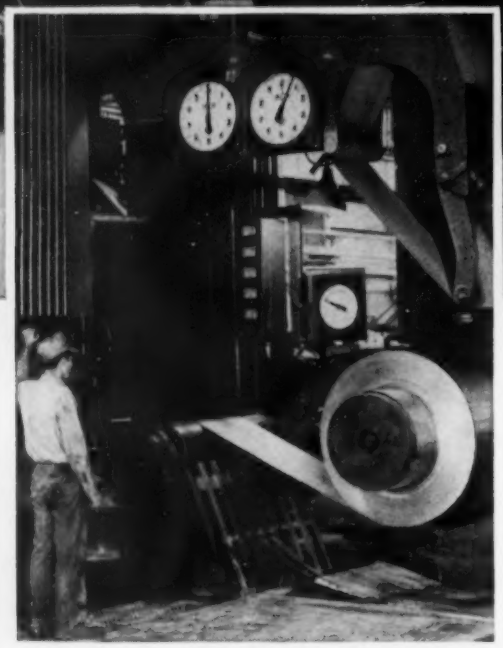
SOUTHERN STEEL PLANT TEMPER



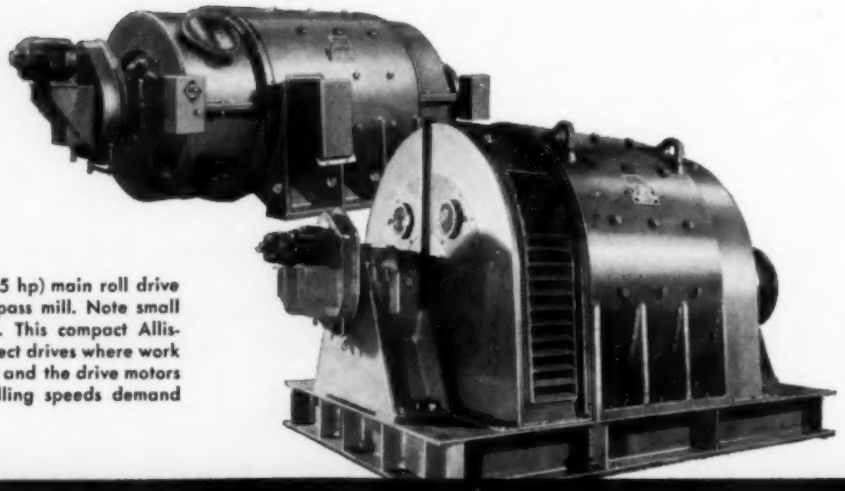
ENTRY END of 3300 fpm four high temper pass mill. Two 100 kw drag generators in foreground; 125 hp top main roll and 600 hp delivery reel motors at left. A 1710 kw M-G set supports this mill.



DELIVERY END of four high temper pass mill. Notice the two large, high visibility dials of the Screwdown Indicator. This Direct Current Remote Indicating device gives a constant, accurate indication of roll setting and strip thickness. The Screwdown Indicator is equipped with a remote reset to enable calibration of the roll setting directly from the operator's position.

ROLLING ALONG STEADILY, producing quality sheet and coil strip, the above four high temper pass mill has broken tonnage records at the largest southern steel plant.

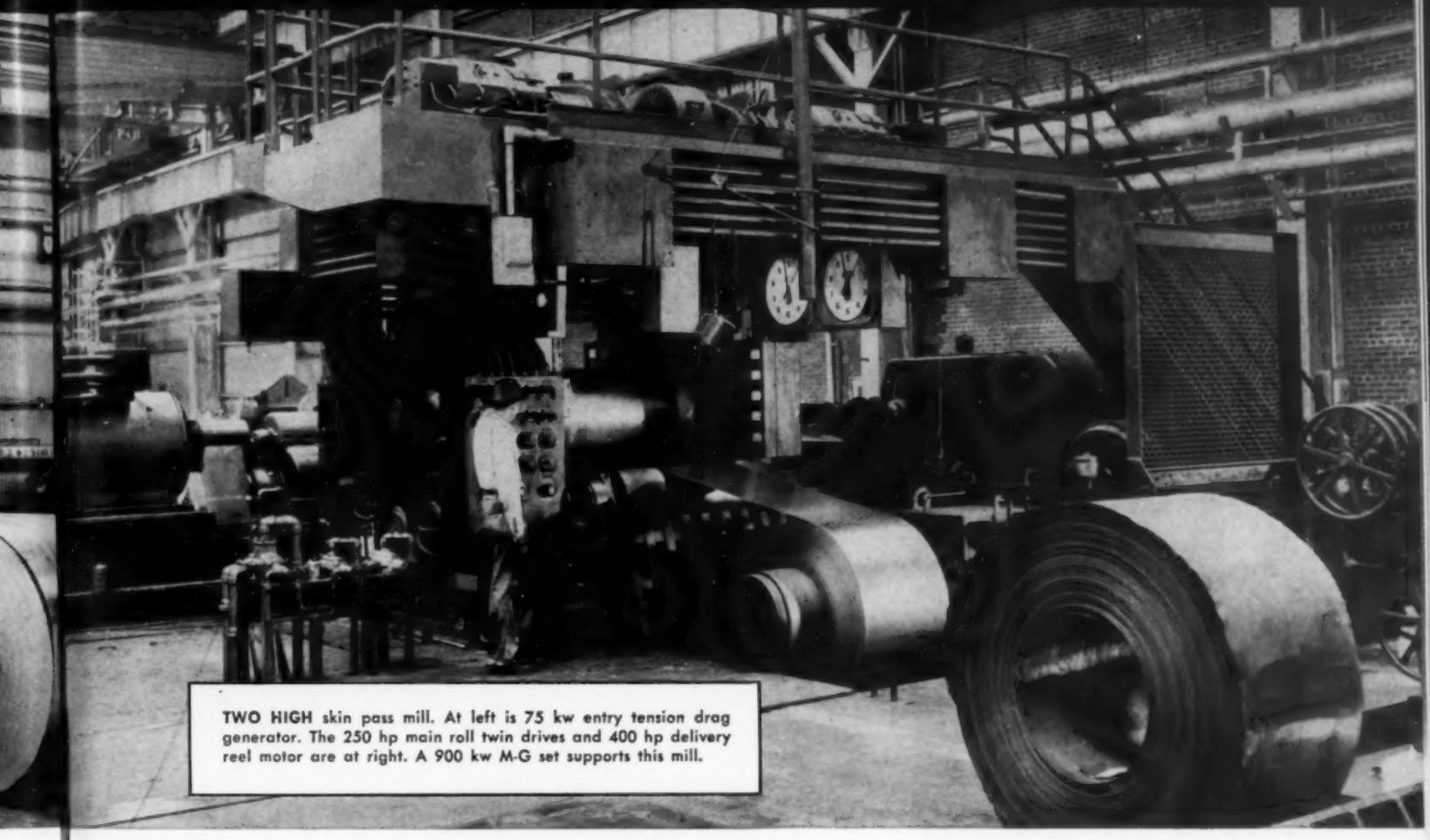
Five two stand, four high tandem temper mills — driven, supported and controlled by Allis-Chalmers—were installed here in 1938. Having regularly delivered quality tinplate production beyond rated capacity, their performance and



TOP (125 hp) **AND BOTTOM** (1125 hp) main roll drive motors for the four high temper pass mill. Note small diameter of the top drive motor. This compact Allis-Chalmers design is valuable in direct drives where work rolls are small, drive shafts large, and the drive motors placed close together. Higher rolling speeds demand smaller diameter motors.

Rolling Along!

MILLS EXCEED CAPACITY TONNAGES



TWO HIGH skin pass mill. At left is 75 kw entry tension drag generator. The 250 hp main roll twin drives and 400 hp delivery reel motor are at right. A 900 kw M-G set supports this mill.

maintenance record was considered by the steel plant when ordering the two new temper mills shown on these pages.

Both New Mills Allis-Chalmers Equipped

Allis-Chalmers supplied the electrical equipment driving, supporting and controlling *both* the four high and the two high temper mills shown here. Auxiliary drives and controls — for roller leveller, hydraulic systems, conveyors, entry ramps, etc. — also were supplied by A-C. The rolling mills themselves were built by the E. W. Bliss Company.

The individual generator system of support and control is used for both these mills, making them so flexible that they can roll from 30 to 13 gauge, 20 to 48 in. wide. The two high temper mill can roll both coil and cut-to-length sheets. Also, the two high temper mill main rolls have a twin drive with two identical motors, making it unnecessary to grind the work rolls to identical diameters, since variations can be compensated for in the control.

Regulex Exciters Give Automatic Control

Variable voltage dc control is employed in both mills. Wide use is made of *Regulex* rotating amplifier exciters to control tension, reel buildup, and speed matching, as well as the supporting M-G sets. This refined system, giving automatic control of so many critical factors, enables these temper mills to finish roll to exacting quality standards at capacity and above tonnages.

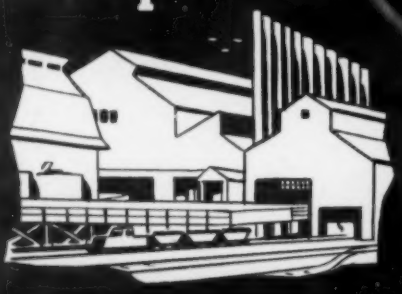
To date, Allis-Chalmers has supplied the drive and control for *forty-five* temper mills, one of the more recent developments in steel rolling. Consult with a pioneer and leader in the application of electric power in the iron and steel industry. *Your* conversion or expansion program also can have reliable Allis-Chalmers electrical equipment. For more information, call your nearest A-C office or write to Allis-Chalmers, Milwaukee 1, Wisconsin. A-3367

Regulex is an Allis-Chalmers trademark.

ALLIS-CHALMERS

POWER, ELECTRICAL PROCESSING EQUIPMENT FOR IRON AND STEEL

in the majority of open hearth shops



here's why TAYCO-40 is the preferred high temperature silica cement

Leading steel mills use Tayco-40 for bonding all silica and super silica bricks and shapes where tight, uniformly thin joints are required. The life of silica brick crowns are prolonged, as Tayco-40 keeps joints *tight*, preventing penetration by fluxes and iron oxide vapor. Hot patches on ring-type roofs are easier when Tayco-40 is used for bonding the ring joints. Masons can tear out the area to be patched without chasing joints all over the roof—a situation that usually occurs where ring joints are laid dry and are grouted with a watery slurry of "silica clay" or mortar.

Tayco-40 is the most *workable* silica cement yet developed! It has excellent water retention properties and can be dipped, poured or trowelled. Easy-to-use Tayco-40 is *economical*. Due to its remarkable *smooth*-working properties, Tayco-40 goes 2½ times as far as ordinary silica cements. Less cement is used; thinner, tighter joints are obtained; losses in mixing and handling are reduced. If your open hearth shop is not yet using Tayco-40, write now for a sample and your copy of Bulletin No. 507.

Refractorers to industry since 1864.

TAYLOR — TAYLOR SILLIMANITE

The **CHAS. TAYLOR SONS Co.**

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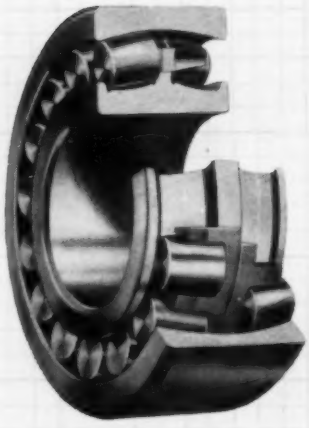
spotting heavy loads

with Torrington Spherical Roller Bearings



Harnischfeger Corporation uses Torrington Spherical Roller Bearings for the trolley drive of P & H overhead cranes to assure smooth and dependable operation.

Spherical Roller Bearings automatically compensate for shaft deflection and frame distortion so that binding stresses are avoided. These precision bearings require a minimum of maintenance attention.

For continuous on-the-job reliability of your heavy-duty equipment, ask our engineers to help you incorporate the advantages of Torrington Spherical Roller Bearings.

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TORRINGTON *SPHERICAL ROLLER* **BEARINGS**

SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • BALL • NEEDLE • NEEDLE ROLLERS

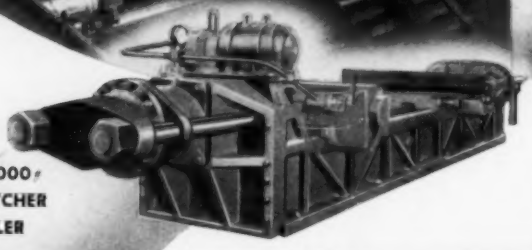
STEEL MILL EQUIPMENT

Precision built

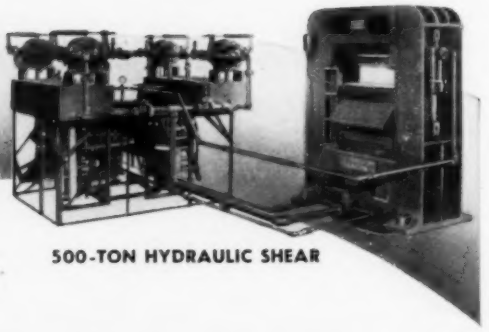
BY

F & Y m

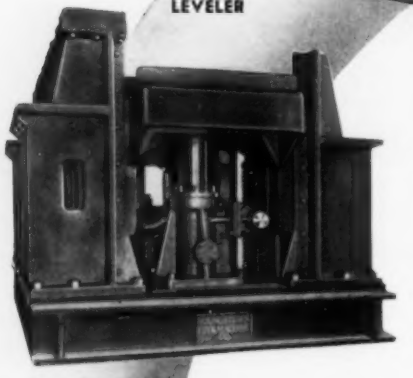
100" SCRUBBER LINE



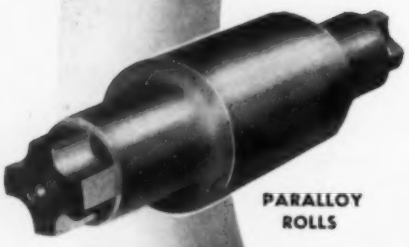
800,000# STRETCHER LEVELER



500-TON HYDRAULIC SHEAR



SLAB PILER



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Check this List for the Products You Need

- PARALLOY ROLLS (Pinch, Coiler, Tension, Steel Mill)
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- HOT SAWS—ROCKING AND SLIDE TYPES
- HOT BEDS—COOLING BEDS—TRANSFERS
- BILLET EJECTORS—PINCH ROLL STANDS
- SLITTERS—SPECIAL SHEARS AND GAUGES
- TILTING TABLES—Traveling and Lifting Tables
- Continuous PICKLING Lines—ROLLER LEVELERS
- FURNACE Charging Equipment—Furnace Pushers
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Machinery Built to Customer's Design and Detail Drawings

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OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Youngstown, Ohio

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ORIGINATED BY
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OPEN HEARTH CRANES

That's right. Not only does Alliance build the world's most efficient cranes . . . Alliance builds the biggest!

Cranes for hot metals, raw materials, finished products . . . Alliance builds them all.

Alliance cranes are safer, easier and more economical to operate and they're always built for your specific requirements.

United States Steel, for example, will use a special twenty-four wheel Alliance Open Hearth Crane in their new Fairless Works at Morristown, Pa.

This 400 "tonner" will be **the biggest Open Hearth Ladle Crane in the world**—engineered to perfection so the load is always distributed equally, each wheel taking a proportional share of the load.

Alliance experience covers a wide range of industries. This year we are celebrating our Fiftieth Anniversary serving the steel industry throughout the world.

Alliance engineers will be happy to discuss ways to give your plant extra lifting power for the days ahead. Write for a consultation.

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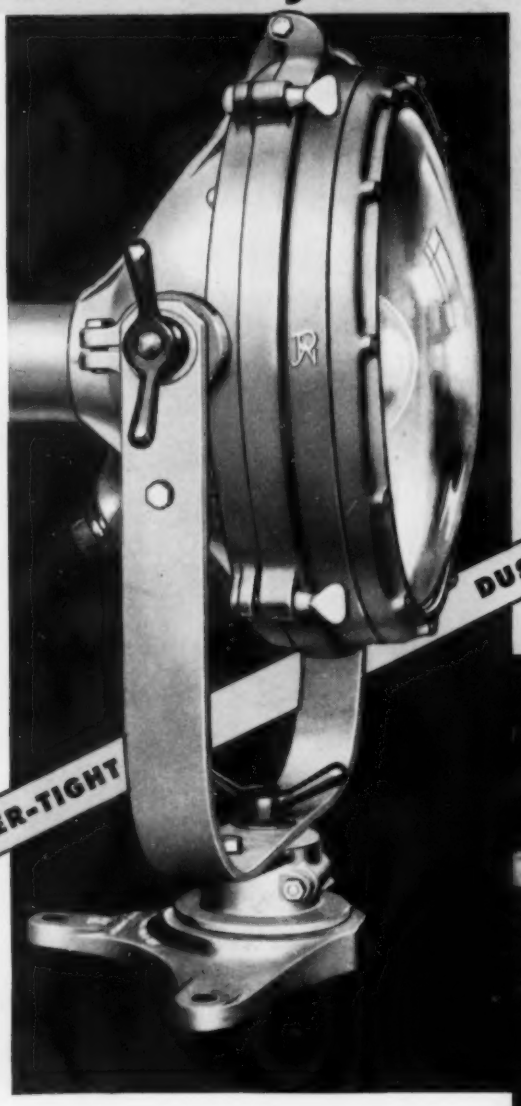
Consider the years ahead!



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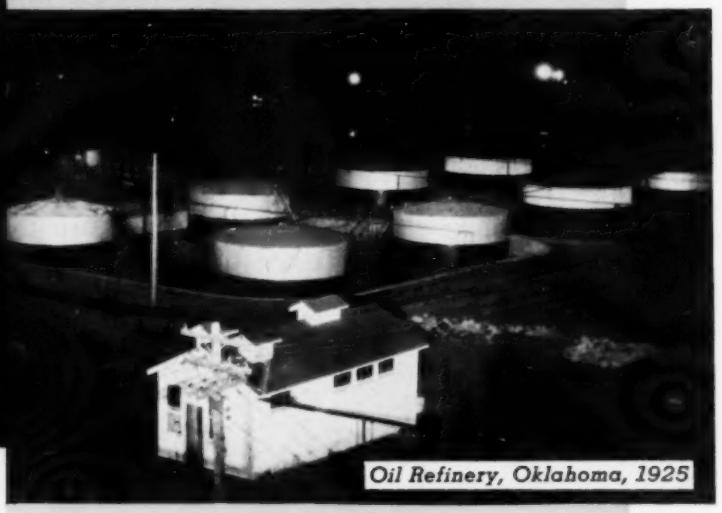
ENCLOSED FLOODLIGHTS



Oil Refinery, Oklahoma, 1925

Don't economize on the initial cost when planning a floodlight installation. It is the elimination of large maintenance, repair and replacement expense that counts.

Sealed against moisture and dirt, constructed throughout of rugged, corrosion-proof materials, Pyle-National floodlights retain their original high-efficiency output throughout an exceptionally long service life, with negligible maintenance and replacement expense.

The earliest Pyle-National floodlighting installations are still operating in excellent condition, with *over a quarter of a century* of efficient, economical service to their credit! Convincing proof of the value of quality, enclosed floodlights.

Write for catalog 2100, which gives a complete description of our extensive line of heavy duty floodlights.

The services of our experienced floodlighting specialists are available at all times to advise and assist in installation problems.

THE PYLE-NATIONAL COMPANY

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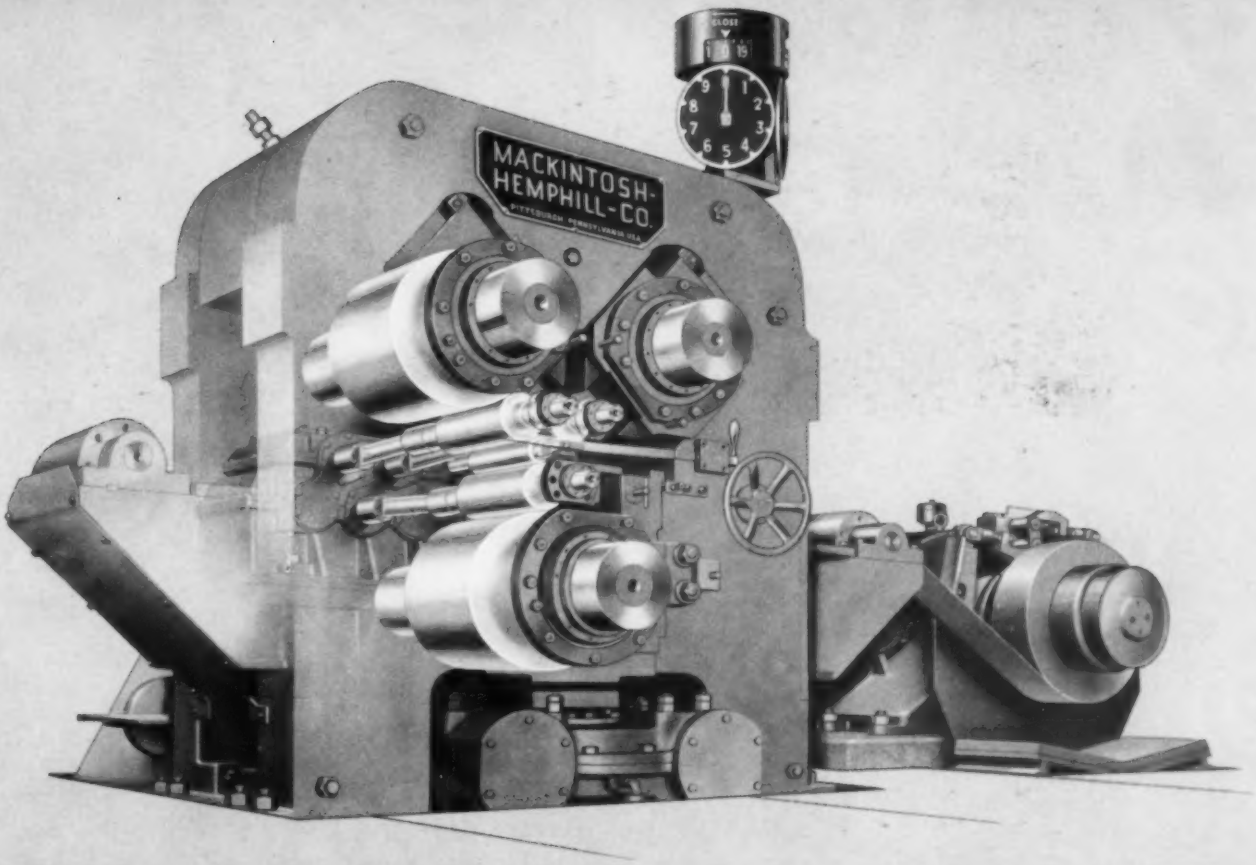
COLD ROLLED STRIP

★ 20 inches to 60 inches wide
★ ferrous or non-ferrous metals
★ gauges down to 0.005 inches
★ production speed 1200 FPM on finish pass

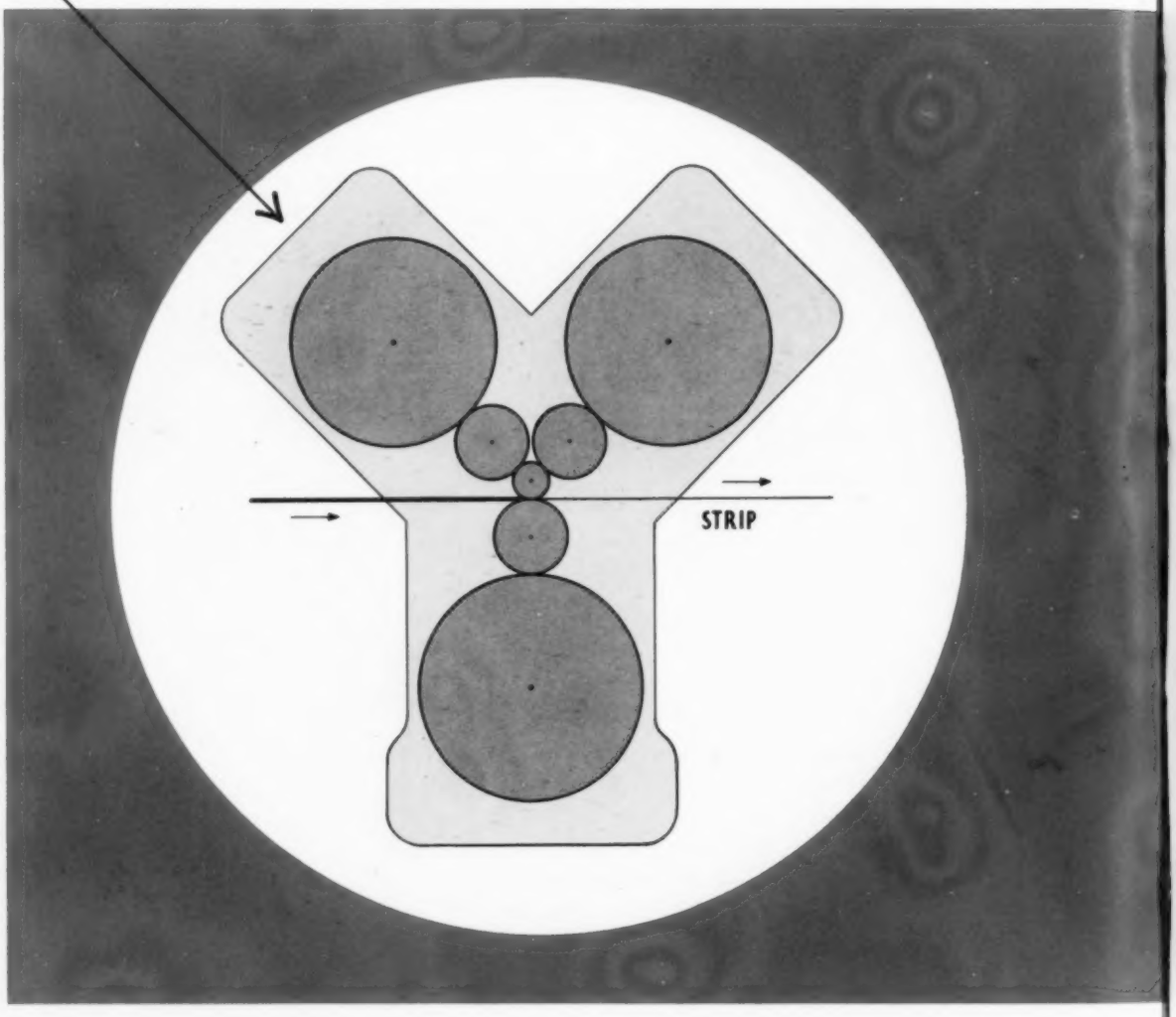
with a Mack-Hemp Y-Mill



the modern reversing cold strip mill which combines the advantages of

- small diameter work rolls
- power for deep draft and high speed
- simple and compact arrangement

The Mack-Hemp Y-Mill employs a unique arrangement of rolls which establishes the "Y" design of the housing:



This roll combination results in greater penetrating ability than a conventional 4-high mill, with greater accuracy of finished gauge and equivalent surface finish.

In actual operation, the Mack-Hemp Y-Mill has exceptional productive capacity on hard metals, permits elimination of many intermediate anneals, and produces a uniformly rolled strip.

The design features, operating procedures, and tentative reduction schedules are discussed in a new publication, "THE MACK-HEMP Y-MILL". Your own numbered copy of this new publication will be sent you immediately, if you'll write us on your business letterhead. Address: Mill Division, Mackintosh-Hemphill Company, 911 Bingham, Pittsburgh 3, Pennsylvania.

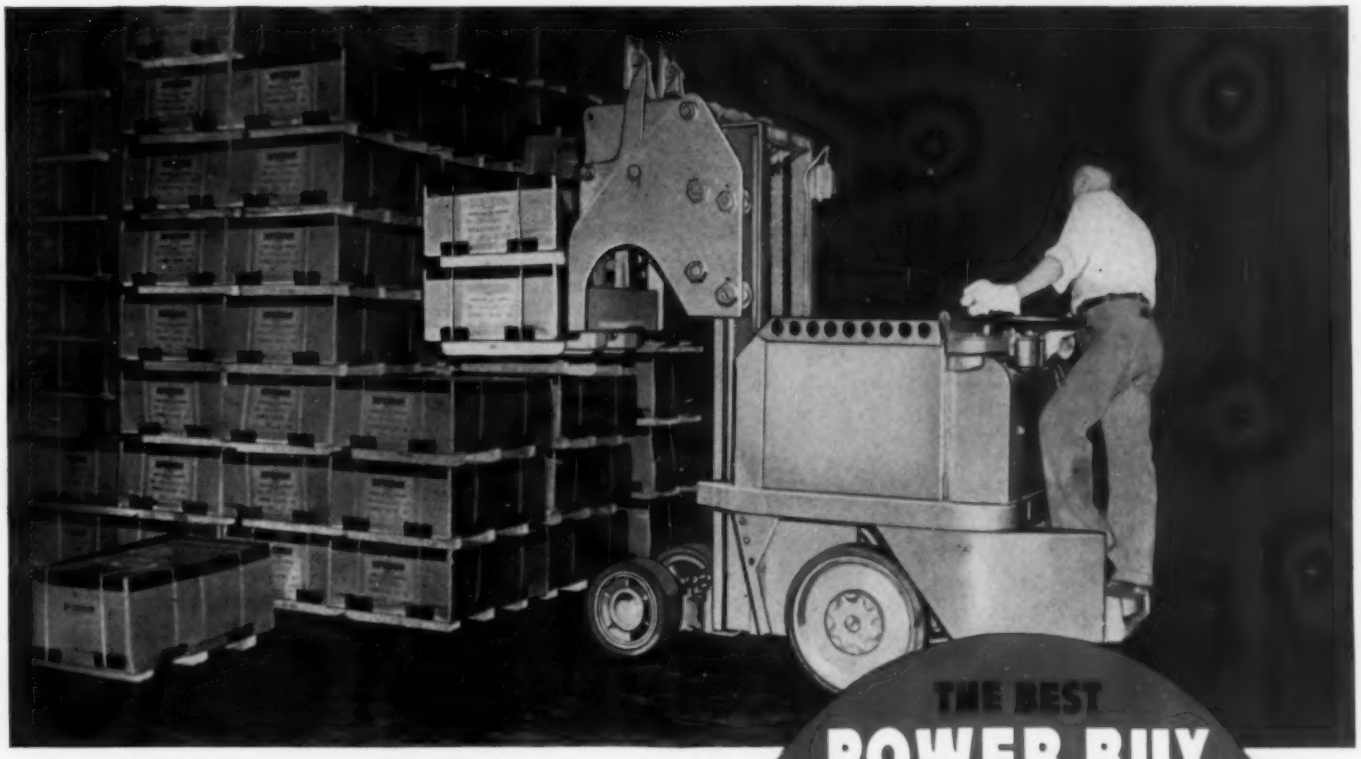
MACKINTOSH-HEMPHILL CO.

PITTSBURGH and MIDLAND, PENNSYLVANIA

Makers of the Rolls with the Striped Red Wabblers

Mackintosh-Hemphill Products Include: ROLLS . . . STEEL AND SPECIAL ALLOY CASTINGS . . . COMPLETELY INTEGRATED STRIP MILLS . . . HEAVY DUTY ENGINE LATHES . . . MACKINTOSH-HEMPHILL ROTARY STRAIGHTENERS . . . IMPROVED JOHNSTON PATENTED CORRUGATED CINDER POTS and SLAG-HANDLING EQUIPMENT . . . SHAPE STRAIGHTENERS . . . END-THRUST BEARINGS . . . SHEARS . . . LEVELLERS

INTO THE STRETCH WITH SPEED TO SPARE



No letdown during the shift, no slowdown at the end! That calls for *dependable* power, *long-lasting* power. You get both when your battery-electric trucks are Exide-Ironclad equipped. You get steady, uniform speed throughout each shift, with as much tonnage moving in the final hour as in the first. Exide-Ironclad Batteries also give you:

INSTANT SURGE OF POWER, plus finger-tip control, split-second handling, easy maneuvering, accurate spotting.

ROUND-THE-CLOCK PERFORMANCE—no mechanical troubles, no unscheduled down time.

LOW OPERATING COSTS—on the average of 4 cents an hour for power . . . batteries absorb a very high percentage of charging current.

LOW MAINTENANCE COSTS—seldom more than 15 cents per shift.

EXCEPTIONALLY LONG LIFE — proved on more than 100,000 heavy-duty jobs.

INHERENT SAFETY — freedom from the hazards of fire, fumes, noise and uncleanliness.

There are Exide-Ironclad Batteries for every size and make of battery-electric truck.

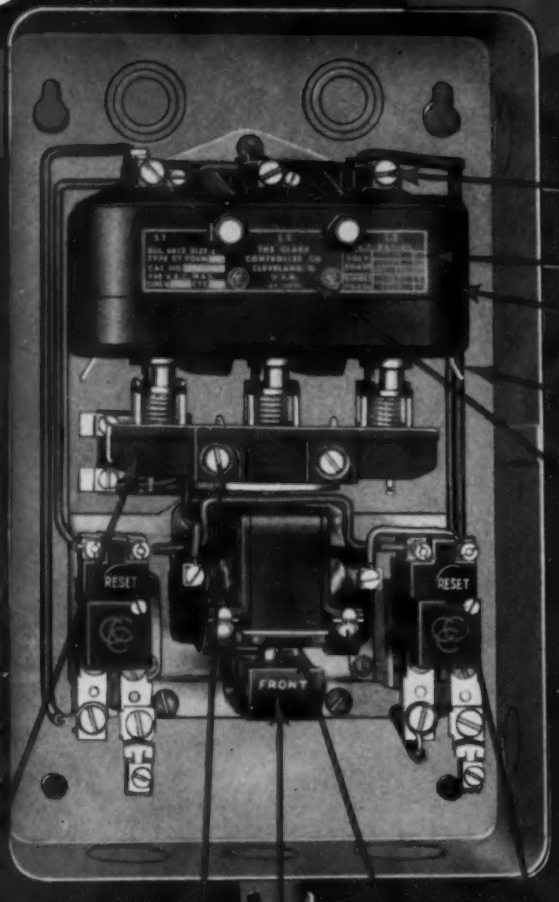
Write for more facts and FREE copy of the new Exide-Ironclad Battery Motive-Power Catalog, Form 5161.

THE ELECTRIC STORAGE BATTERY COMPANY
Philadelphia 2
Exide Batteries of Canada, Limited, Toronto
"Exide-Ironclad" *Reg. Trade-mark U. S. Pat. Off.*

1888 . . . DEPENDABLE BATTERIES FOR 63 YEARS . . . 1951

It's All New! The CLARK "CY" AC Motor Starter

The Starter



PRESSURE TYPE TERMINALS LINE AND LOAD

ONE PIECE UPPER ARC SHELL PROTECTS TERMINALS FROM HOT GASES

ARC SHIELDS OF INORGANIC NON CARBONIZING MATERIAL

FINGER CLIPS FOR EASY CONTACT INSPECTION

MAGNETIC ARC INTERRUPTERS WITH STEEL ARC CHAMBERS

SILVER FACED [illegible] CONTACTS [illegible]

[illegible] TYPE OVERLOAD RELAYS

CAPTIVE SPRING IN CONTACT ARM

EASY COIL REPLACEMENT ONLY TWO SCREWS AND ONE PIN TO REMOVE

VERTICAL LIFT MAGNET WITH STEEL GUIDE USES NO SPRINGS

another CLARK FIRST!

Here, for the first time is a rugged AC magnetic starter that provides the extra protection and dependable operation of "Mill-Type" heavy-duty construction and design at *no premium above ordinary starter prices!*

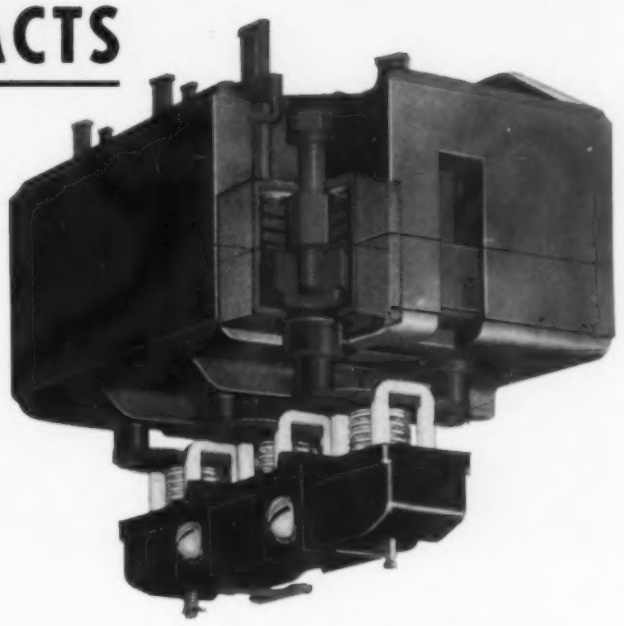
Let a CLARK application engineer show you what this BLUE RIBBON PRODUCT means to you in increased production and lower maintenance.

CLARK ENGINEERED ELECTRICAL CONTROL

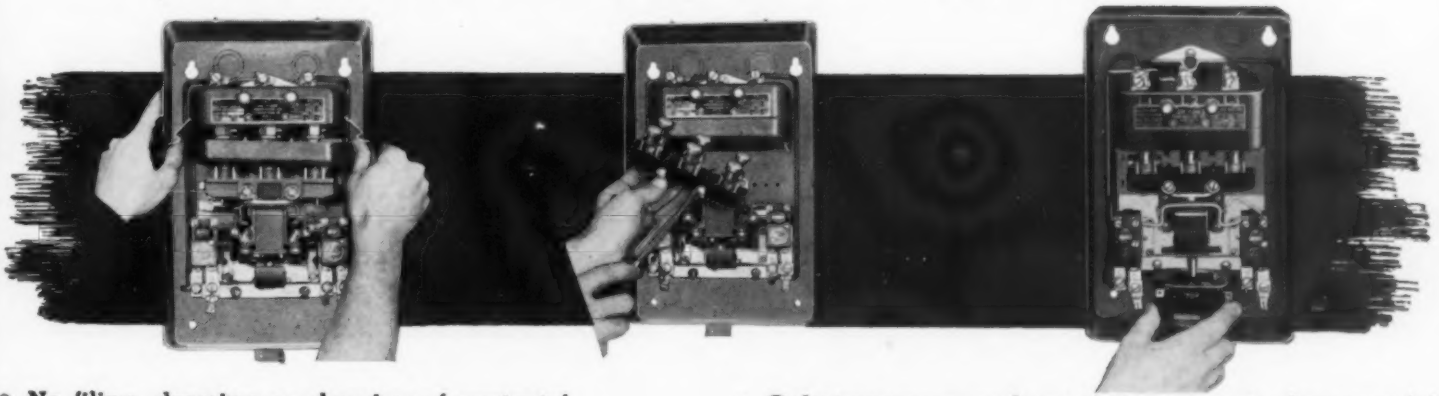
with the sensational NEW multi-turn magnetic blowouts

and TWIN-BREAK CONTACTS

The "CY" starter employs an entirely new principle of arc interruption. The arc is extinguished by the effect of the blow-out coil, *concentric with the contact.* The magnetic field quenches the arc either by lengthening or confining it. In its *forced rotation* it moves continually from a hot to a cold spot —preventing burning or pitting of contacts. The ingenious design of the arc chamber prevents carbonization and the accumulation of ionized gases between wiring terminals —minimizing phase-to-phase failures.*



The Maintenance Man's Dream!

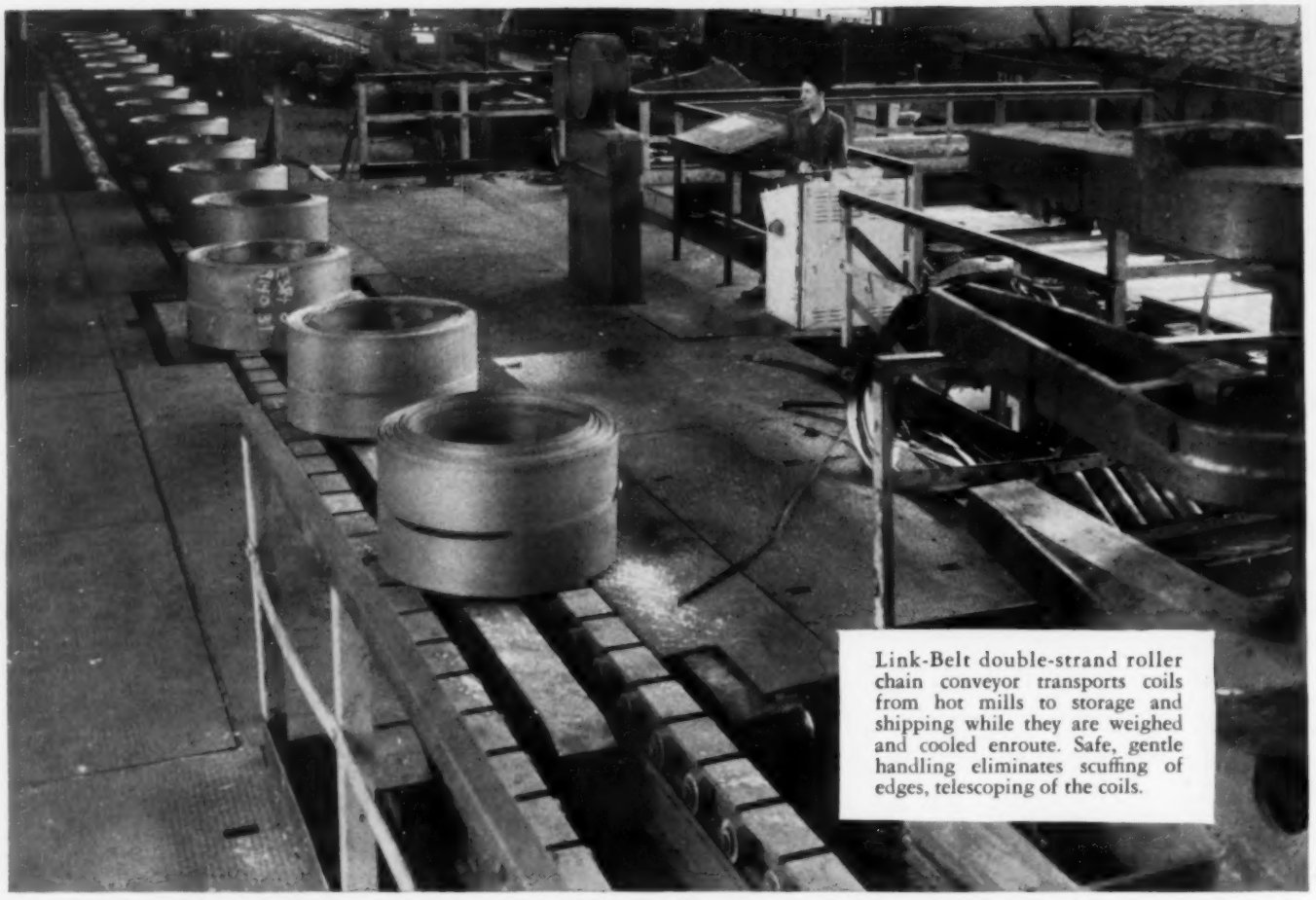


- **No filing, dressing or cleaning of contacts!**
- **No tools necessary to inspect contacts!**
- **Easy to change moving contacts!**
- **Stationary contacts changed quickly with screw driver!**
- **Only two screws and one pin to remove to change coils!**
- **Only four screws to remove to take out stationary magnet frame!**
- **Power circuit contacts available with springs in complete packaged service kits for ease in stocking!**

**Magnetic blow-out coils are used on all size 2 and 3 "CY" starters. Sizes 0 and 1 use the same general Mill-Type construction as the larger sizes.*

THE CLARK CONTROLLER CO.

1142 EAST 152ND STREET • CLEVELAND 10, OHIO



Link-Belt double-strand roller chain conveyor transports coils from hot mills to storage and shipping while they are weighed and cooled enroute. Safe, gentle handling eliminates scuffing of edges, telescoping of the coils.

MOVE up to 75,000 lb. COILS . . .

and get less scrap loss, greater safety

Yield goes up . . . waste goes down . . . with LINK-BELT Coil Handling Equipment

EVER-increasing rolling mill capacity and the trend toward larger coils require heavier conveyor systems capable of handling greater tonnages.

Since the inception of the continuous strip mill, Link-Belt has pioneered coil handling equipment. Now America's steel mills can choose from three basic Link-Belt conveyor types . . . designed to cover the complete range of operating needs.

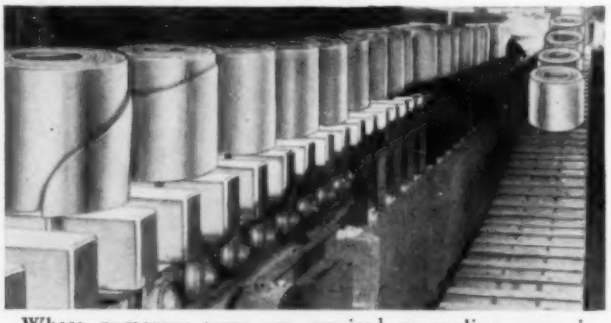
Our engineers will work with your own engineers, consultants and builders of mill and process equipment. If you are contemplating expansion, it will pay you to call your nearest Link-Belt representative.

LINK-BELT

MATERIALS HANDLING, PROCESSING and POWER TRANSMISSION MACHINERY

LINK-BELT COMPANY: Chicago 9, Indianapolis 6, Philadelphia 40, Cleveland 15, Pittsburgh 13, Atlanta, Dallas 1, Houston 1, Minneapolis 5, San Francisco, 24, Los Angeles 33, Seattle 4, Toronto 8, Offices in principal cities. 12.417

The above illustrates pickled coils up to 40,000 lbs. being lifted from Link-Belt Wide Pallet Conveyor and weighed automatically. Other conveyors for similar service are designed for coils up to 75,000 lbs. each.



Where numerous turns are required or cooling space is limited, Link-Belt Car-Type Conveyors are best. Coil never leaves its car. Without rolling or scuffing of edges, coils go around corners, up and down inclines.

If You Want To REDUCE MANPOWER TURNOVER...

CUT HANDWORK CASUALTIES AND COSTS...

LET THE BILLETEER DO IT...

Be production-wise — go modern, with BONNOT BILLETEERING!

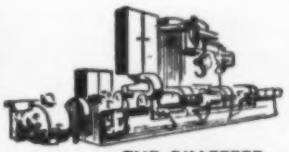
Right away manpower shortages and turnover problems solve themselves because OPERATORS appreciate the safety and easy, finger-tip control of the *Bonnot Billeteer*.

And YOU — with the speed and efficiency of *Bonnot Billeteering*, can better meet today's "quantity and quality" demands by stepped-up output of better-conditioned billets. *Billeteering* also enables you to reduce inventories — makes chips 100% recoverable — eliminates excessive re-melting — guarantees accurate scheduling.

Your inquiry will bring prompt facts and figures on what can be done in your plant to meet the production demands and the cost problems of the accelerating mobilization market.

Engineered for Improved Production

The Bonnot Co.
STEEL EQUIPMENT DIVISION
CANTON 2, OHIO



THE BILLETEER

Also Manufacturers of — SAWING • CRUSHING • PULVERIZING AND MIXING EQUIPMENT • BILLET INSPECTION TABLES
DUST PUG MILLS • SINTER PLANT PUG MILLS

Bailey GOGGLE VALVES

Open & Close *Instantly*

WHETHER OPERATION IS FREQUENT OR OCCASIONAL

THERMAL

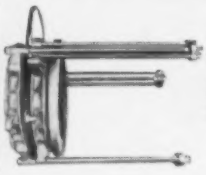
MECHANICAL

THERMAL EXPANSION TYPE

Steam passing through steel tubes causes linear expansion sufficient to free the goggle plate. When the steam is removed, normal cooling contracts the tubes, clamping the goggle plate with a gas-tight seal. In case of steam failure this type Bailey Valve can be operated mechanically.

MECHANICAL TYPE

A powerful, hand-operated clamping device assures a positive, gas-tight seal around the entire periphery of the valve. The goggle plate is released and clamped by the same powerful mechanism.

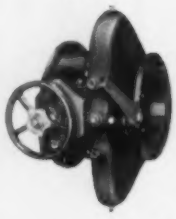


THERMAL

Made in diameters of 36" to 120"

MECHANICAL

60" x 48" Bailey Valve for Horizontal Gas Main. Sizes 6" to 72"



ENCLOSED

For use near open flame a totally enclosed type is furnished

Here is the means to instant service in shutting off gas mains in emergencies or for repairs . . . regardless of the length of time the valves stand unused. Soundly designed and built of the highest quality materials, Bailey Goggle Valves have repeatedly proved themselves dependable on gas washers, blast furnace mains, precipitators and boiler plants. With their positive, gas-tight seals, Bailey valves protect men and equipment, and assure economy through long, maintenance-free service.

WILLIAM M. Bailey COMPANY

ENGINEERS

LEADERSHIP THROUGH QUALITY

1221 BANKSVILLE ROAD PITTSBURGH 16, PA

ROLLS for ROLLING BILLETS

PITTSBURGH ROLLS

PITTSBURGH ROLLS DIVISION OF BLAW-KNOX COMPANY • PITTSBURGH, PA.

STOP RUST WITH RUST-OLEUM

Why let rust—the most destructive enemy of American industry—rob you of expensive, hard-to-replace machines, tanks, stacks, ducts, pipe, metal sash, fire escapes, and other valuable equipment?

Use RUST-OLEUM in your plant to protect your property. For 25 years RUST-OLEUM has proved its capacity to stop rust for many nationally known manufacturers. Its tough, pliable, rust-resisting film gives excellent protection that prevents rust losses under many difficult rust-producing conditions—salt air, dampness, industrial fumes, and general weathering.

RUST-OLEUM can be applied *even* over rusted surfaces. It is not necessary to remove all the rust. Just remove scale and loose rust by [illegible] and wire brushes. You save time and labor on maintenance because no chemical preCleaning or sand blasting is usually required.

A qualified RUST-OLEUM specialist will [illegible] rust problems and help you develop a program of plant-wide rust control to defer many costly replacements — to conserve the available supply of new metal for national defense.

Industrial Distributors in principal cities of the United States and Canada carry complete stocks for immediate delivery. Plan your needs—order *now!* See our complete catalog in *Sweet's* which also tells the nearest source of supply. Or, write on your company letterhead for full information.

"RIGID ECONOMY, MON!"

Available in many COLORS aluminum and white

Beautifies as it Protects

RUST-OLEUM CORPORATION
2443 Oakton Street, Evanston, Illinois

Bearing costs are low on 2-high mills

THIS Lewis 2-high skin pass mill is now in operation at the West Leechburg plant of Allegheny Ludlum. It handles stainless strip in coils up to 60 inches and 15,000 pounds in weight. To keep down bearing costs—maintenance, lubrication, and replacement—the main roll necks are mounted on Timken® tapered roller bearings. And Timken bearings are also used in the breaker blocks, screw down, tension reel, and main mill drive.

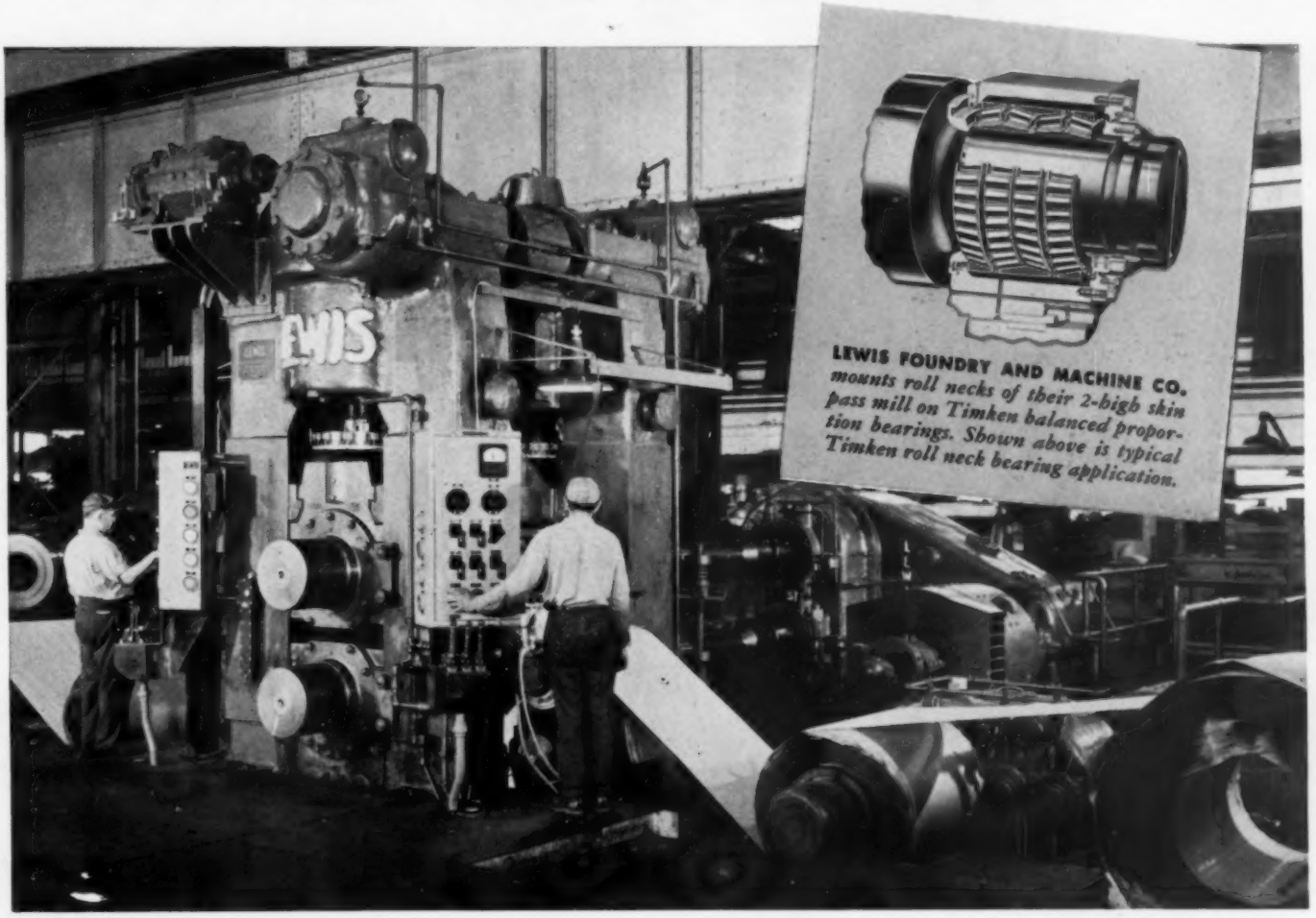
Timken roll neck bearings give greater mill rigidity because of balanced proportion design. Higher rolling speeds are possible because Timken bearings operate freely, frictionlessly.

Timken bearings permit the use of simple, economical grease lubrication, eliminating the use of complicated and costly systems. Rolls can be changed faster, more easily.

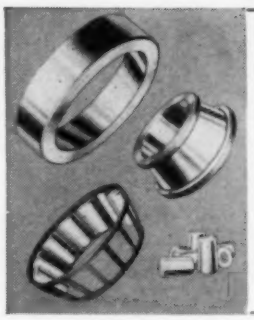
And Timken bearings are made of the finest material ever developed for tapered roller bearings—Timken fine alloy steel. Rollers and races are case-hardened to give a wear-resistant outer surface and a tough, shock-resistant inner core. Line contact between rollers and races means extra load carrying capacity.

Consult our roll neck bearing specialists for full information. Write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



LEWIS FOUNDRY AND MACHINE CO. *mounts roll necks of their 2-high skin pass mill on Timken balanced proportion bearings. Shown above is typical Timken roll neck bearing application.*



DESIGN LEADERSHIP

The first Timken tapered roller bearing was produced in 1898. Since then the one-piece multiple perforated cage, wide area contact between roll ends and ribs, and every other important tapered roller bearing improvement have been introduced by The Timken Roller Bearing Company.

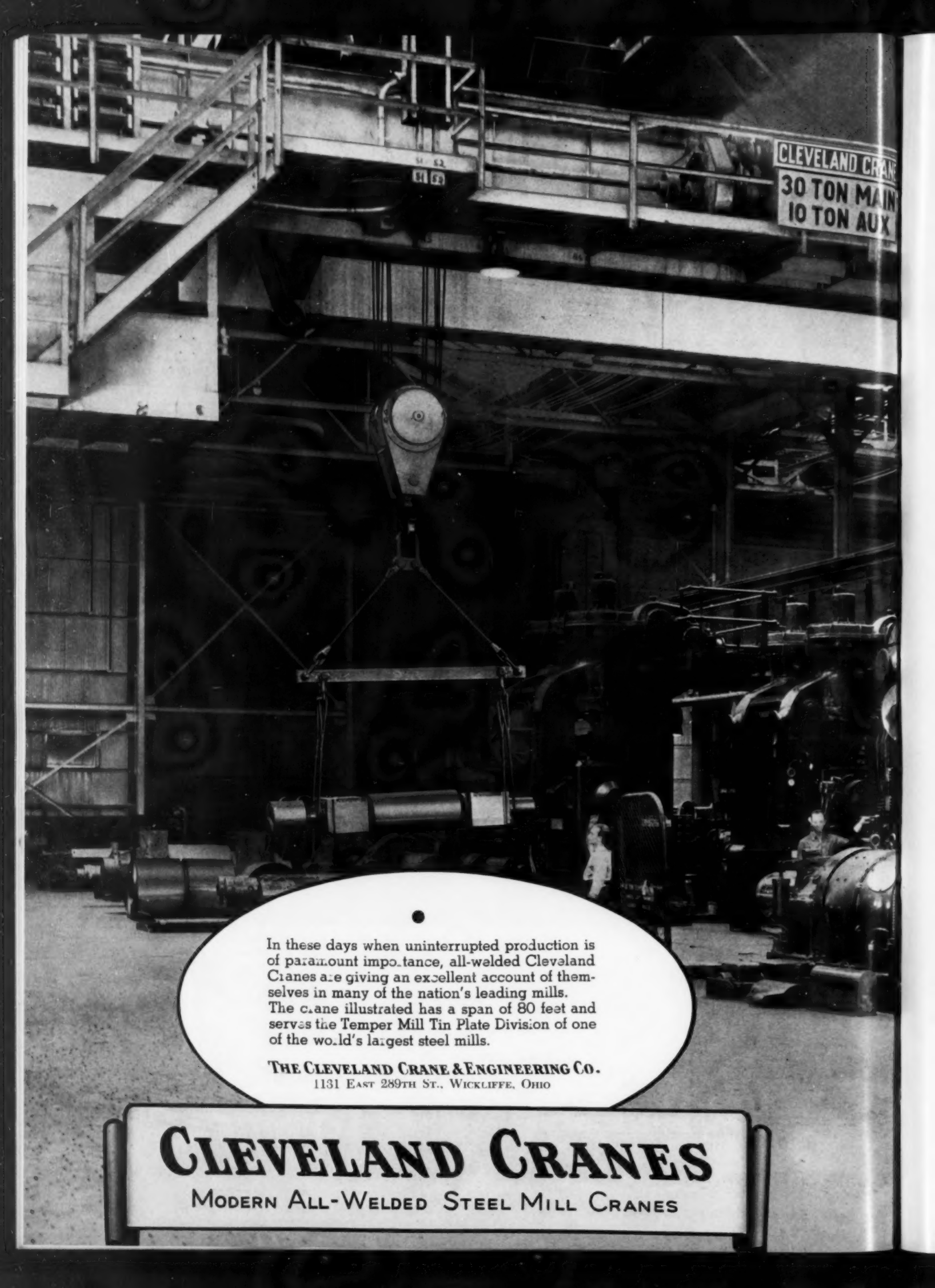
The Timken Company leads in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ **NOT JUST A ROLLER** ▭ **THE TIMKEN TAPERED ROLLER** ▭ **BEARING TAKES RADIAL** ◫ **AND THRUST** →◫← **LOADS OR ANY COMBINATION** ✳



In these days when uninterrupted production is of paramount importance, all-welded Cleveland Cranes are giving an excellent account of themselves in many of the nation's leading mills. The crane illustrated has a span of 80 feet and serves the Temper Mill Tin Plate Division of one of the world's largest steel mills.

THE CLEVELAND CRANE & ENGINEERING CO.
1131 EAST 289TH ST., WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops and Shorts

ADDRESSING the 59th general meeting of the American Iron and Steel Institute, C. M. White, president of Republic Steel Corp., recommended a campaign of education to show the true relationship between profits and productivity on one hand and higher living standards on the other. He said he was sure employees don't believe that higher productivity is the only safe way of increasing wages and getting better goods at lower prices. Republic has already given many of its supervisors a short course in basic economics, and through its plant publications, posters, communications to its employees, etc., has attempted to show the advantages of cooperative effort.

Mr. White pointed out that each new job created in the steel industry now requires an investment of about $90,000 for plant facilities and other factors, as against $10,000 - $15,000 only a decade ago.

▲

IN the course of some announcements at the New York meeting of the Institute, Walter Tower paraphrased the barracks-room ballad popularized by General MacArthur, saying "Old Democrats never die; they just smell that way."

▲

INCIDENTALLY, you may not believe that statement about old soldiers just fading away if you try to put on the uniform you wore when you were in the service.

And one columnist observes "Old gardeners never die; they just spade away."

▲

THE Bessemer medal for 1951 was awarded to Benjamin F. Fairless, president of United States Steel Corp., by the British Iron and Steel Institute, in recognition of his distinguished services to the iron and steel industry. In presenting the award, Sir Charles Goodeve, director of the British Iron and Steel Research Association, said "Ben Fairless exemplifies in himself just those qualities that we need most today and will likely continue to need for a long time to come — initiative, technical ability and courage."

▲

WITH vacation season hard upon us, one of our pessimistic friends says that a vacation is one-half anticipation and the other half regretting mistakes in selecting places to eat and sleep.

▲

UNDER construction at an Austrian plant is a commercial scale unit to produce steel by the Suess process. In this method, which has been worked out in a pilot plant, molten iron is poured into an open-top ladle containing some scrap and burnt lime, and an oxygen jet is played over the surnace of the bath. Steel of open hearth quality is produced in about 20 minutes.

▲

A FRIEND of ours is promoting the idea of a single term for all legislators, who should then be made to return home and try to make a living under the laws he helped pass.

▲

TOP men of the steel industry are becoming more concerned about over-production than about under-production. Curtailment of civilian uses and restrictions on credit are helping to cut demand, while some markets for consumer goods seem to be approaching the saturation point.

▲

SENATOR ROBERT A. TAFT says "The Administration's idea of a bipartisan policy is to announce their own decisions and expect all Republicans to support those decisions."

▲

SCARCITY of scrap continues to threaten capacity operations of the steel industry. The American Iron and Steel Institute has issued a bulletin urging top management to step up programs to go after dormant scrap. The bulletin recommends an emergency inspection and inventory of all heavy steel, whether equipment or materials, with scrapping and write-offs on all possible items, together with continuous follow-up in both plant and community.

▲

OLD pioneers of the West who prided themselves on their speed on the draw could take lessons from today's wives who have joint checking accounts.

▲

A LARGE company that spends a substantial amount of money for research estimates that for each $1000 spent by its research and development group over the past 10 years, they have gained $3700 on royalties, $9600 on improvements in existing processes and products, and $2100 on new processes and products. This is a return of $15.40 for one.

▲

ALTHOUGH readers of this page may not realize it, almost every one of them practices pogonotomy daily.

▲

IT is pretty well established that the industry and public members of the Wage Stabilization Board were quietly and unofficially cleared with the United Labor Policy Committee.

▲

THERE were probably just as many careless drivers 50 years ago, but the horses had more sense. Nowadays, no matter how careful the driver, he can't keep his automobile from running into money.

MOLD HANDLING CRANES

When your Mold Handling Cranes are "Shaw-Box," you have the advantages of dependable crane service, low operating costs, and exceptional maintenance convenience — even under the most unfavorable conditions. They are the product of exacting "Shaw-Box" engineering, skillful design, advanced manufacturing techniques, and precision workmanship.

Steel Mill Cranes have long been a "Shaw-Box" specialty. Working closely with the men in the Steel Industry, "Shaw-Box" engineers have gained the intimate understanding of mill requirements that produces the simple, rugged cranes steel men strive for in their specifications. Each "Shaw-Box" Steel Mill Crane is an outstanding example of how full an interpretation can be made of individual mill or AISE specifications, at practical prices.

"Shaw-Box" Cranes are used with confidence wherever dependability is demanded.

Be sure to send all your inquiries for Steel Mill Cranes and Soaking Pit Carriages to "Shaw-Box"

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

MANNING, MAXWELL & MOORE, INC.
SHAW-BOX CRANE & HOIST DIVISION
MUSKEGON, MICHIGAN

Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, 'American' Industrial and 'Microsen' Electrical Instruments.

5

reasons why the steel industry likes

HAGAN RING BALANCE METERS

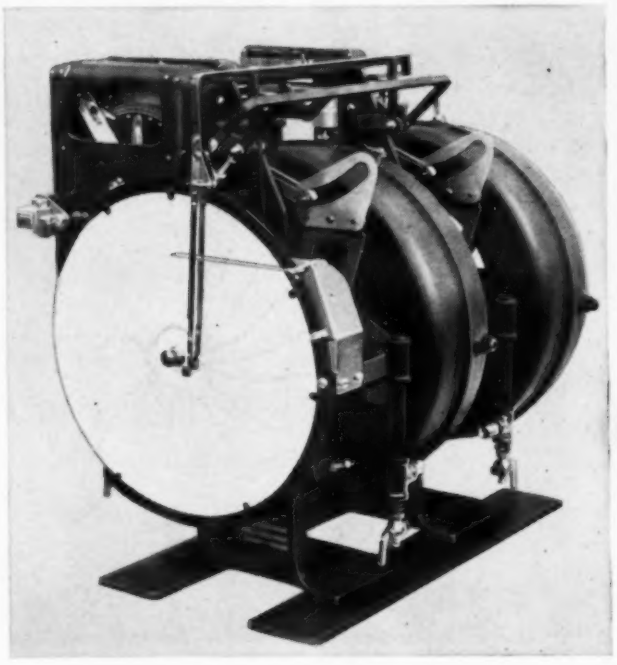
1 **THEY ARE SENSITIVE**–Torque is high, because rings have large cross-sectional area. Friction is low, because of knife edge suspension. The result is exceptionally high torque-to-friction ratio.

2 **THEY ARE ACCURATE**–Maximum rate of ring rotation occurs at low flow rates. Ample power to operate recording, integrating and other mechanisms is available over entire scale. High accuracy at low flows is especially advantageous where turndown range is wide.

3 **THEY ARE ADJUSTABLE**–Each ring assembly is adjustable for full scale differential over a range of 7 to 1. Rings are available for a continuous differential measuring range of ½ inch to 420 inches water column.

4 **THEY ARE SIMPLE**–There are no stuffing boxes or pressure tight bearings. No dampening devices are used. Level of mercury, or other sealing fluid, is not critical.

5 **THEY ARE RUGGED**–Design and materials produce precision results throughout a long life, requiring a minimum of personal attention, and costly maintenance.



Typical Hagan Ring Balance Dual Flow Meter with two low pressure-low differential rings — for recording and integrating gas flow and recording air flow.

For more detailed information on Hagan Ring Balance Meters, just fill out and mail the coupon or write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pa.

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

Hagan Corporation
Hagan Building
Pittsburgh 30, Pennsylvania

Please send me further information on Hagan Ring Balance Meters. I am particularly interested in .....

NAME .....

POSITION .....

COMPANY .....

STREET AND NUMBER .....

CITY ..... ZONE ..... STATE .....

ISE-6

WEAN

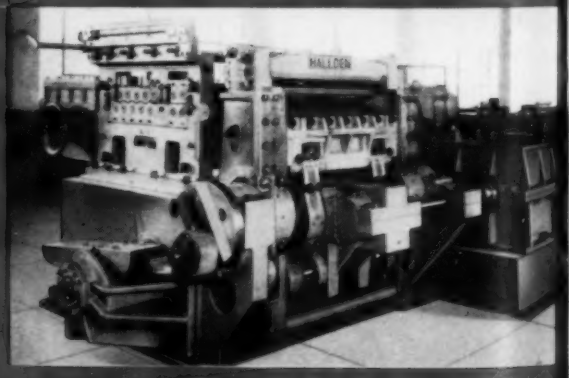
SHEET AND TIN PLATE SHEARING

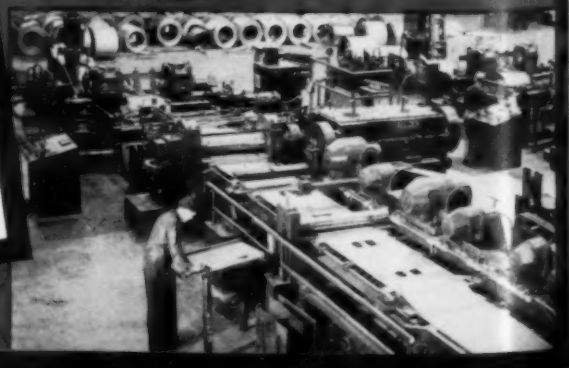
Lines

• High-speed, high-tonnage production . . . unsurpassed accuracy . . . rugged construction that minimizes operating and maintenance costs.

Modern Wean sheet and tin plate shearing lines for converting strip in coil form to flat sheets provide all these advantages.

SPECIALISTS IN SHEET, TIN *and* STRIP MILL EQUIPMENT





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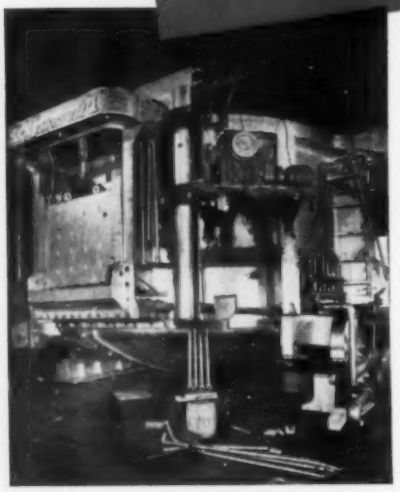

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ELECTRIC FURNACE OR OPEN HEARTH?

. . . . under certain conditions, the electric furnace may make steel at costs competitive with efficient open hearth costs . . . .

By C. F. RAMSEYER
Ramseyer & Miller, Inc.
New York, N. Y.

▲ EVER since the end of the war there has been talk from time to time by electric furnace enthusiasts to the effect that a really modern electric furnace melt shop could produce ordinary carbon steel ingots at a cost competitive with that of the open hearth. This paper records the results of an attempt to explore, insofar as possible, the facts and factors behind this talk. Many of the figures and opinions presented herein are necessarily more or less hypothetical in nature, since no straight carbon steel electric furnace melt shop with a capacity equal to that of a large modern open hearth plant has as yet been built. Nor can any existing electric furnace shop be said to be wholly "modern," in the sense that it has been laid out to take full advantage of the latest developments in electric furnace operation and design.

In order to stay as close to actual practice as possible, our comparison initially will be between an "ideal" basic electric furnace shop melting all cold scrap — the design of which we propose to develop later on — and a modern hot metal basic open hearth shop. The term "modern" applied to a present day open hearth plant, in addition to implying recent construction, also means furnace units of large size, i.e., tapping heats of 225 to 275 tons. The biggest single difference in operating cost between the two different types of steel producing plants is the cost of fuel, in which the open hearth has the double advantage not only of using low cost fuel but also of receiving a large part of its charge already molten in the form of hot metal.

The fuel consumption of the numerous large new hot metal open hearths now under construction or planned will probably be close to 3,200,000 Btu per ton on an annual average basis. With 150,000 Btu fuel oil at 7¢ per gallon, this is equal to a fuel cost of $1.50 per ton of ingots. The electric furnace's "fuel" cost on the other hand — made up of electric power + electrode consumption — is nearly four times as high as this. The lowest average power consumption figure that can safely be assumed for straight carbon steel is about 475 kwhr per ton of ingots melting all cold scrap. At a power cost of 8 mills and with a graphite electrode consumption of 9½ lb per ton @ 18¢ per lb, the electric furnace's fuel bill is $5.51, or $4.00 per ton higher than the open hearth's. The extent to which the electric furnace can overcome this large difference in fuel cost by savings in other operating and production costs is therefore what we propose to investigate.

In order to get properly oriented for this study, we first need to know something about the past development and present-day characteristics of electric furnaces and electric steel-making.

The early electric steel furnaces — 1906 saw the first heat of electric steel poured in the U. S. — were relatively small melting units designed primarily to compete with the crucible furnaces used by tool steel manufacturers for melting high grade metallic charges requiring little or no refining. The electric units proved well adapted for this purpose, and electric steel rapidly supplanted that made by the crucible process as shown by the fact that while over 100,000 tons of crucible steel were still being produced here as late as 1918, its production had dropped to 2500 tons by 1930 and to 24 tons in 1945, the last year that a separately recorded figure for crucible steel is given by the American Iron & Steel Institute. The electric furnace thus firmly established its position as a quality steel producer from the very beginning. A good many years were to pass, however, before steelmakers first began to consider it seriously as a producer of ordinary carbon steels.

Perhaps the dominant characteristic of the American steel industry over the past 75 years has been the steady increase in the size of the major production units that has taken place as a result of the steelmaker's continual struggle to obtain lower costs. In common with this trend, the capacity of the early 4 to 5-ton Heroult furnaces was gradually increased until during the first World War, units over 15 ft in diameter powered by 2500-kva transformers were built which tapped 25-ton heats. The trend towards constantly larger units did not stop there, but continued until by the end of the second World War nearly a score of 20-ft diam, 20-in. electrode, furnaces with a nominal capacity of 70 tons were in service, a few of which were provided with transformer capacities as high as 15,000 kva. The word "nominal" is used because heats as large as 107 tons are being made regularly in at least one plant in these 20 ft units, which are still the largest size electric steel-melting furnaces in operation in the U. S. at the present time. (An exception to this statement is an oval 6-electrode 100-ton unit built in 1927, which is still in regular production as this is written.) However, four 22-ft furnaces designed for 24-in. electrodes are understood to have recently been either ordered or definitely planned, making it apparent that, as in the case of the open hearth, the trend to larger units still continues.

The main difference between open hearth and electric furnace practice is the way heat is applied to melt the charge. In the open hearth, where melting is done by a high temperature flame, removal of the resultant large volume of hot flue gas limits the rate at which fuel can be burned, and consequently the maximum rate of output from the furnace. While it is true that the output

of open hearth furnaces has been raised greatly by increasing their size, heat times are ordinarily somewhat longer the larger the furnace. In other words, a modern 250-ton open hearth furnace will not normally have twice the melt rate of an equally modern 125-ton unit, assuming for the moment that an open hearth as small as 125 tons can be called "modern." Many of the latest 250-ton open hearths will undoubtedly be able to make steel at twice the rate of existing 125-ton furnaces, but the latter do not have all the refinements in design and controls provided for the former.

In the case of the electric furnace on the other hand, the temperature differential between the arc and the charge is so great, and the area or volume occupied by the arc is so small, that except for eventual electrical limitations as to voltage and electrode size, the theoretical rate at which heat can be developed in it is practically unlimited. That is to say, the rate of melting in an electric furnace can be increased in direct proportion to the increase in heat size by stepping up voltage and transformer capacity, so that the heat time in a large furnace need be no longer than in a small one. The possibilities inherent in this fact have only recently been recognized by a few electric furnace designers and operators; an attempt to take advantage of it was first made a year or two ago on a 17-ft shell furnace in a small non-integrated Midwestern meltshop. The largest size transformers previously used on any 17-ft diam furnaces had had capacities of 10,000 to 12,000 kva. At this plant, however, a 25,000-kva transformer, capable of a maximum output of 40,000 kva for a short period of time, was installed. In spite of crowded operating conditions and very light scrap requiring several recharges per heat, this furnace has established a melt rate considerably above that of any other electric furnaces in the country, averaging well over 20 tons per furnace hour, tap-to-tap.

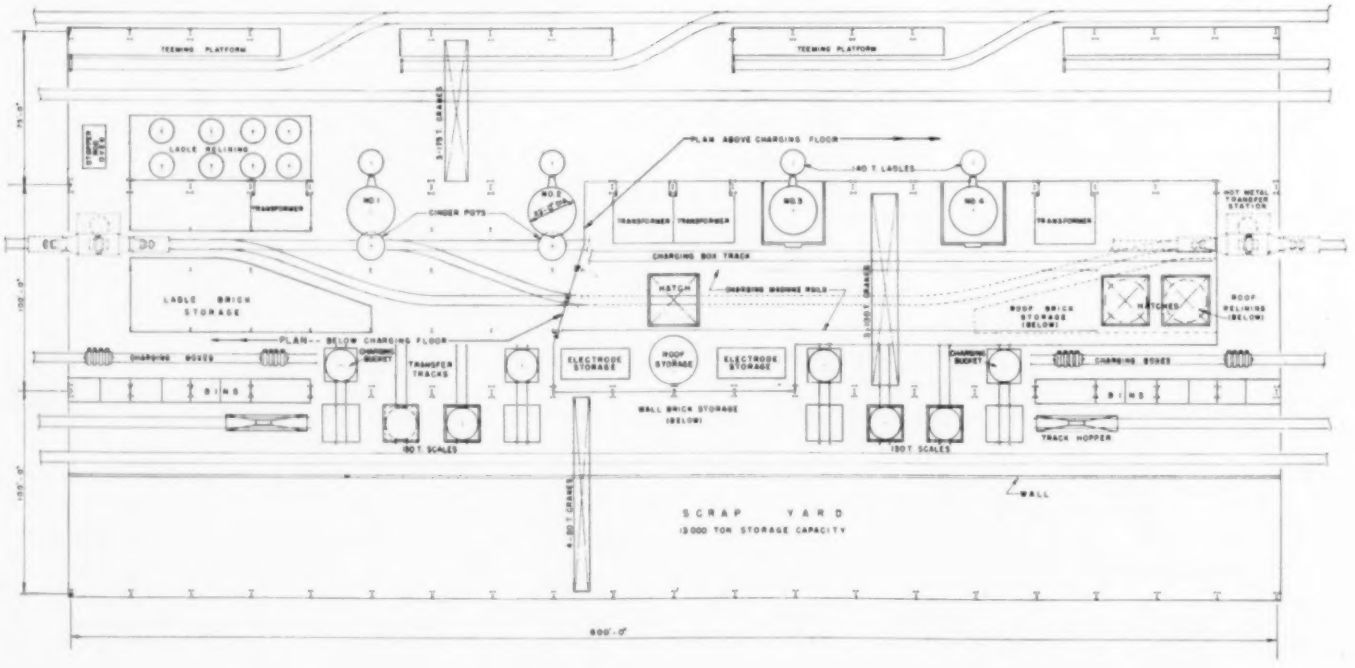
Top charging and a maximum rate of energy input are therefore the two main factors that must be relied on if the electric furnace's serious disadvantage as regards fuel cost is to be overcome. As far as this study is concerned, these two are the most important characteristics distinguishing electric furnace practice from the basic open hearth process which produces 90 per cent of this country's total ingot output. However, the electric furnace has a number of other design, operating and metallurgical characteristics which should be discussed before we attempt to design our "ideal" meltshop and evaluate its possible production costs.

From the metallurgical point of view, the fact that electric furnaces are tilting furnaces is advantageous as it means that they can both be tilted backward for removing slag, or tilted towards the pit for tapping into the ladle. A tilting furnace can also always be tapped at the precise time when the heat is ready with no danger of delay because of tap hole trouble or from a slow tap due to too small a hole. The rate of tapping is under better control, and tap hole maintenance is considerably simplified compared to a stationary furnace.

Small heats — down to 40 or 50 per cent of capacity — can also be made more readily in an electric furnace than in a stationary open hearth, and the same is true as regards the slagging off and making of new slags, an especially valuable ability when an unexpected high sulphur melt is encountered. Unlike fuel oil, the arc contains no sulphur, and single slag electric furnace heats consistently average several points lower in sulphur than open hearth steel made from the same charge materials.

Due largely to the fact that in the early days the high quality of electric furnace steel was thought by some metallurgists to result primarily from the fact that it was melted under relatively reducing conditions, it was believed for a long time that rimmed steel could not be produced successfully in the electric furnace. Since the war, however, millions of tons of rimmed steel

Figure 1 — General arrangement of electric furnace plant.



have been made in electric furnaces and it has also been found possible, if desired, to carry a higher FeO in the slag in an electric furnace than in an open hearth, perhaps due to the higher local temperature obtainable under the arc. On the other hand, if a highly deoxidized steel is desired, the FeO in an electric furnace slag can be reduced to one per cent or less if necessary — a flexibility of which the open hearth is incapable.

Because of its round, roughly spherical shape, and the absence of checker chambers and flues, the electric furnace has little external surface from which to lose heat. This compactness, coupled with the centralized location of the arc, melting largely from the bottom up, and its relatively short heat times of 3 to 5 hours, compared to 10 to 12 hours for the open hearth, enable the electric furnace to produce steel with only a fraction of the heat required by the open hearth. For example, 475 kwhr is equal to a gross heat input of 1,620,000 Btu per ton, or about one-third that used by the average all cold charge open hearth. On the other hand, this relatively small amount of heat at 8 mills per kilowatt hour costs $2.35 per million Btu compared to only 46¢ per million for 7¢ per gallon fuel oil. This adverse ratio of more than 5 to 1 plus the high cost of graphite electrodes accounts for the electric furnace's $4.00 per ton greater fuel cost.

The above Btu figures are of interest as they show that from the national point of view, a modern electric furnace plant uses no more fuel on the average — assuming a central power station efficiency of 33 per cent — than an open hearth melting the same charge. Moreover, while electric energy can be made from all kinds of fuel, the low sulphur fuel oil necessary for maximum open hearth production is becoming increasingly difficult to obtain. A further point in this connection is that judging by the past, the cost of electric energy is not likely to increase as rapidly as the price of oil, since our reserves of coal and water power, not to mention the possibility of atomic energy, are many times greater than in the case of petroleum, and the efficiency of large central power stations is still steadily increasing.

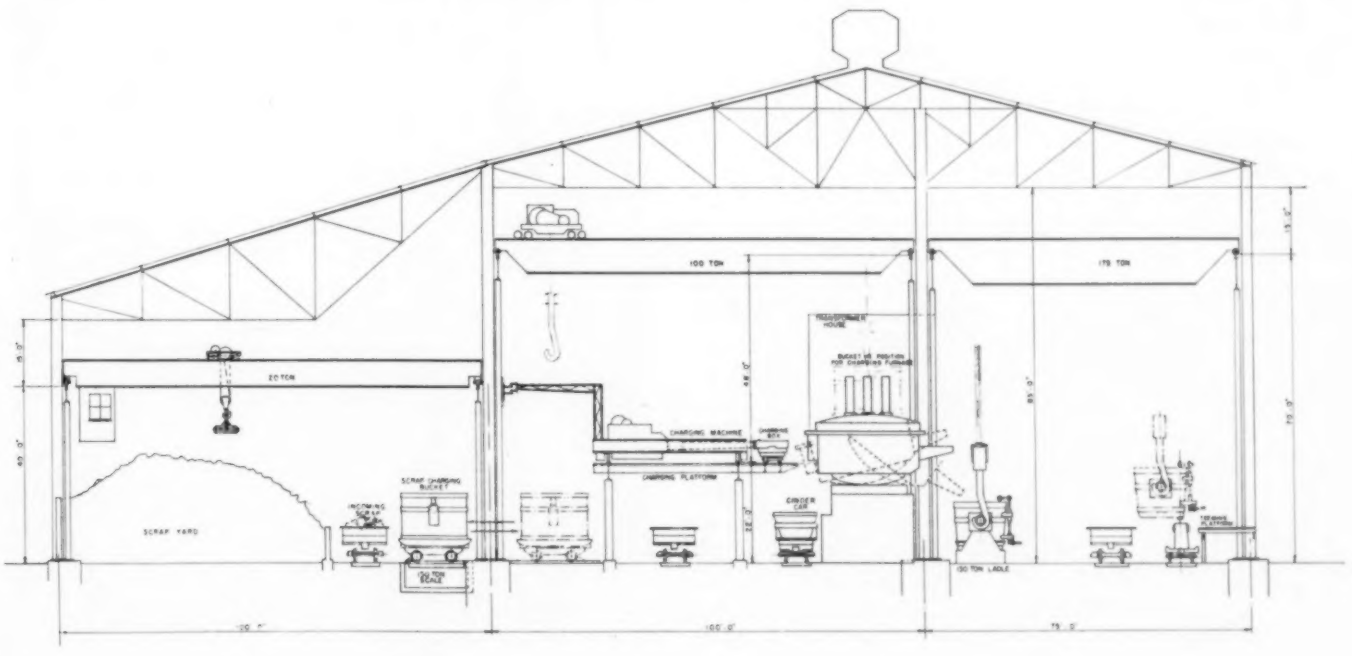
The production of an additional 25 million tons of electric steel ingots per year — about 25 per cent of our ingot capacity — would require the burning of 6 million extra tons of coal in central power stations. This would increase our annual coal consumption by about 1 per cent.

Because it is a very large consumer, an electric furnace plant is a desirable customer for a power company, provided its system is big and "stiff" enough to absorb the very heavy current surges involved in arc furnace melting. A steel meltshop normally operates with a high load factor (ratio of average to peak load) since it runs 24 hours a day, 7 days a week. The average power requirement of a single million ton per year electric furnace plant is 54,000 kw, which is ample to justify the installation of a highly efficient generating unit of large size. Utility companies, also have the advantage of usually being able to finance large additions to their power capacity on favorable terms due to the relatively great stability of their earnings. This point is of importance in comparing the relative capital cost of electric furnaces versus open hearths. As a result of the fact that electric furnaces require considerably less space and refractories than open hearths of equivalent steelmaking capacity, an electric furnace shop can be built for about 50 per cent of the cost of an open hearth plant, provided purchased power is used.

THE TOP CHARGE ELECTRIC FURNACE

When the term "modern" is applied to an electric steel furnace, a top charged unit is meant. All early electric furnaces were made with side charging doors in conformity with the normal design of open flame metal-

Figure 2 — Cross section of electric furnace plant.



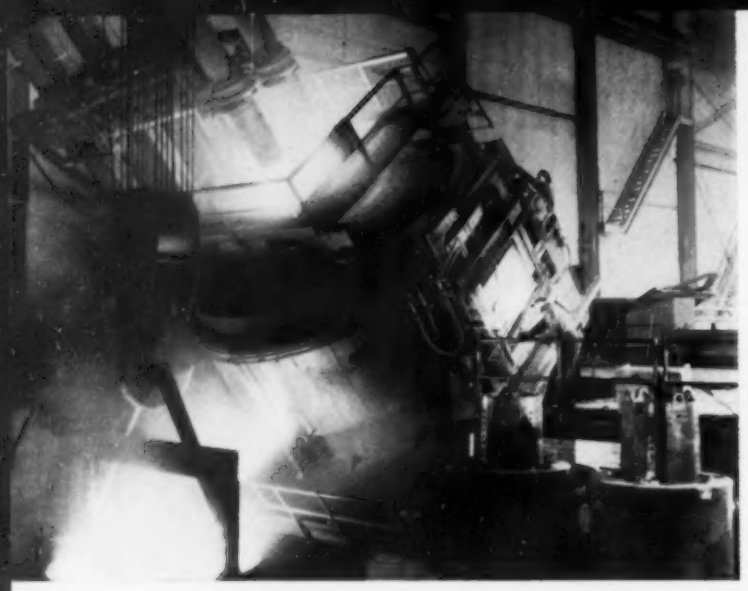


Figure 3 — A tilting furnace has the advantage that it can be tapped at the precise time desired.

lurgical melting furnaces. About 20 years ago, electric furnace manufacturers began to design some of their small furnaces so they could be charged from the top by removing the roof. This made it possible to fill the whole furnace volume at one time by dropping into it the contents of a large drop bottom bucket. The roof was then replaced, the electrodes lowered and the power turned on, the whole sequence taking only a few minutes time.

By the time World War II broke out, the design of these so-called "top charge" furnaces had been extended to units with shells up to 17 ft in diameter tapping 45 to 50-ton heats. At that time, most electric furnace melters felt that door charging with the conventional open hearth charging machine was preferable on larger size units so that the scrap could be more accurately placed in the furnace. By the end of the war, however, the greatly increased melting rate of top charged units compared to door charged ones had become so well established, that most melters began to consider the possibility of changing over their large 20-ft furnaces to top charge design and some have already done so.

The big advantage of top charging on large furnaces is that the charging bucket has a volumetric capacity 50 to 75 times that of the customary door charging box; the resultant large decrease in charging time is obvious. Under most conditions, a top charge electric unit will out-produce a door charge one by at least 30 per cent.

Take for example a 20-ft door charge unit tapping 100-ton heats in seven hours. The required charge at 91 per cent yield is 220,000 lb, or 4400 cu ft of scrap at an average density of 50 lb per cu ft. This volume of scrap requires the charging and emptying of 126 thirty-five-cu ft charging boxes per heat. Assuming it takes one minute to move into position and charge one box on the average, the actual time spent in charging would be two hours and six minutes. Top charging on the other hand with a 1950-cu ft bucket (90 per cent of the total furnace holding capacity) at a scrap density of 40 lb per cu ft or 78,000 lb per bucket, will only take 3 buckets — an initial one plus two back charges — for a total time expenditure of 15 minutes. The time saving alone of an hour and 51 minutes, other things being equal, would reduce a seven hour heat time to five hours and nine minutes and show an increase in output as measured by tons per hour of 36 per cent (19.4 vs. 14.3). In addition there would be a reduction in the amount of heat lost from the furnace during the long door charging period that would still further increase the top charged units' time and output advantage, not to mention better thermal efficiency and refractory life (measured by number of heats) due to shorter heats and reduced delay time.

Because of the large size of the top charge buckets — up to 14 and 15 ft diameter on 20-ft shell furnaces — scrap requires less preparation and is loaded more readily with less spill and subsequent clean-up required. Light scrap does not seem to penalize the production rate of a top charge unit in any way; in fact, it is generally thought to offer more surface for heat absorption to the arc than heavy material, and so actually it affords better protection to the walls and roof during meltdown than a charge made up of all heavy crop ends.

AN IDEAL ELECTRIC FURNACE PLANT LAYOUT

With the above points in mind we can start designing the ideal electric furnace plant mentioned earlier. The first big difference between electric furnace and open hearth practice that the designer needs to take into account is the relatively much shorter time of electric furnace heats. This means that furnace delays are more costly as far as loss in production is concerned, and the shop layout should therefore be planned to eliminate causes of delay to the maximum extent possible. The second major difference that should be taken into consideration is the top charging feature of modern units previously discussed. Finally, full use should be made of the fact that electric melting permits very high rates of heat (power) input, with consequent increased hourly output, even though the refining period is not shortened.

In developing a good meltshop layout, it is obvious that all three of the above factors, i.e., elimination of delays, top charging, and high rate of heat input should all be given serious consideration. We propose to start with the matter of delays.

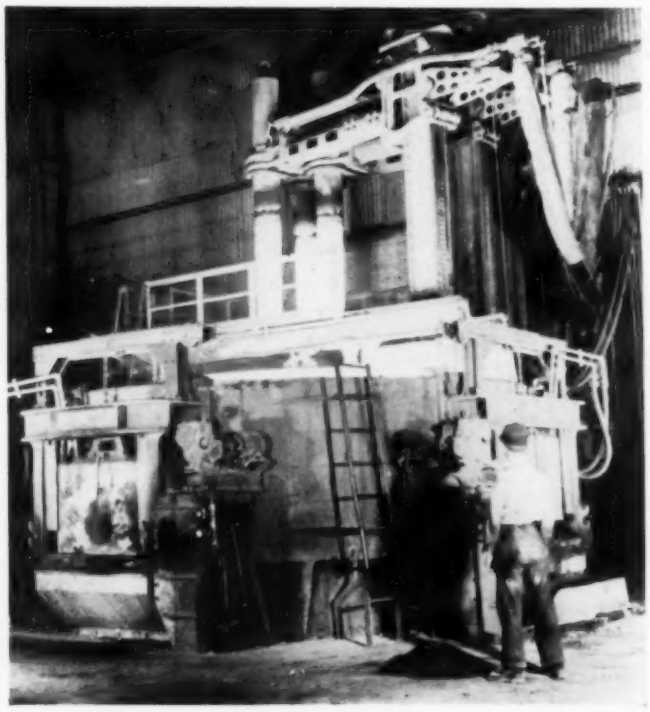
In conventional steel-making practice there are several major sources of delays other than bottom trouble. One of the most important is probably the time lost waiting for delivery of charging materials to the front of the furnace, i.e., scrap handling and scrap delivery delays. Another is pit and charging floor crane delays; these may be electrical, mechanical, or due to the bunching of heats. Lack of floor crane service interferes with the supply of materials to the furnaces, particularly hot metal, and the tying up of a ladle crane means holding the next heat in the furnace until a crane is available. A third major source of delay is the interference with furnace output caused by rebuilding operations on neighboring furnaces. Delays, whatever their cause, always interrupt the flow of materials in the shop with consequent loss of production.

Going back to the first cause of delay, a few figures on the material handling involved in the delivery of scrap to the furnaces of a large meltshop may help our understanding of the problem. In open hearth practice the largest quantity of scrap handled at any one time between the scrap yard and the furnaces is that con-

tained in the charging boxes on a drag of buggies, usually on their way up a highline from the scrap yard to the furnace charging floor. In a modern shop such a drag may consist of up to a dozen buggies each carrying four 45-cu ft charging boxes, corresponding to a total volume of scrap of 2200 cu ft. As discussed earlier, the actual charging of the contents of the boxes themselves after they have been pushed up the highline and spotted in front of the furnace doors, requires a minimum of 2 hours' time at best, assuming that charging can proceed uninterruptedly. In practice, so short a charging period is only possible in hot metal shops where 50 to 60 per cent of the total charge consists of molten pig iron, the charging of which is quite efficient since its density is 5 to 6 times that of loose scrap, and being liquid it can be handled in ladles. Hot metal transfer ladles in a modern shop hold from 60 to 100 tons of metal and pouring it into a furnace requires only a relatively short time. In addition, in most shops hot metal is handled by overhead crane, so that its supply to one furnace causes a minimum of interference with the delivery of scrap buggies to other furnaces.

The size of the charging buckets used will determine to a considerable extent the capacity of the scrap handling facilities to be provided for the new shop, and in order to determine the bucket size we must first settle the size of the furnace we propose to use. In the matter of size, the constant trend to larger steelmelting units is clearly shown by open hearth practice, where in the search for lower production costs, furnace capacities have increased over the past 10 years from a top of 185 tons per heat up to 275 tons, or about 50 per cent. (These figures are for scrap plus hot metal shops — not duplex process blown metal furnaces.) During the same period, there has been no similar increase in the size of electric furnaces, their maximum shell diameter having remained at 20 feet since 1938.

Figure 4 — The fact that the roof can be raised and swung aside allows the operator to charge large quantities in minimum time.



If we were to increase our heat size to the same extent that the open hearth operators have, we would have to propose 159-ton heats, i.e., 50 per cent more than the 106-ton maximum size heats now being made in 20-ft shell units. A 159-ton heat would require a 24-ft furnace with a 35,000 to 40,000 kva transformer, to be comparable to the 25,000 kva transformers being provided on most of the new 20-ft units now being built. However, increases in heat size, shell diameter and transformer capacity of this magnitude in one step are probably greater than most electric furnace designers and operators would be willing to accept. Past increases in furnace diameter have been made very cautiously, normally only a foot or two at a time.

Since we are talking about size, and the main reason for going to larger size electric heats is to reduce production costs, this is as good a point as any to go into the subject of operating costs in electric melting.

Leaving out the cost of metallics, electric furnace operating costs above net metal, (commonly known as the "Cost Above") can be broken down into a number of items. In large furnaces the first four listed below will remain practically constant per ton of ingots regardless of heat size or furnace output in tons per hour.

ELECTRIC FURNACE OPERATING COST ABOVE ITEMS

1. Fuel — made up of power and electrode consumption, plus a small amount for drying and heating ladles.
2. Molds and stools.
3. Fluxes — about 2/3rds of the total used on a long heat will be used even on the shortest heat.
4. The cost of ladle brick, stoppers, and nozzles.

The rest of the Cost Above is more or less fixed per month and will vary but little in a given shop over a considerable range of furnace hourly outputs. It covers the following items:

5. Labor and supervision.
6. Repairs and maintenance.
7. Refractories.
8. Utilities — water, light, air, etc.
9. Yard switching.
10. Laboratory expense.
11. Supplies, tools and lubricants.
12. All other costs, including slag disposal, etc.
13. General plant expense.

Based on the study of a rather limited amount of operating cost data, it appears that if the first four costs (fuel, molds, ladle and fluxes) are eliminated, the remaining costs of operating large electric furnaces per gross furnace hour (i.e. tap-to-tap) appears to be quite constant and relatively independent of furnace size, at least over the range of 16 to 20-ft shell diameters tapping heats from 40 to 90 tons. In other words, leaving out the cost of fuel, fluxes, molds and ladle relining, it costs just about as much to operate a 20-ft electric furnace tapping 90-ton heats as it does a 16-ft one tapping 40 tons. A good average figure for this part of the Cost Above would appear to be about $65 per furnace hour at current prices and wages (March 1951). While the actual data available gives no evidence that these hourly furnace costs vary appreciably within this limited size

range, it seems logical that the cost per hour should increase somewhat as the units get larger. Refractory costs especially should be greater on the bigger furnaces, although the increased distance of the walls and roof from the arc will tend to lengthen lining life. Most other costs should remain much the same.

The relative constancy, regardless of furnace size, of this part of the Cost Above per furnace operating hour furnishes a powerful incentive for increasing the size of electric furnaces in order to get lower costs; unit costs are bound to come down as tons per hour go up. However, in order to be on the safe side a slight increase of hourly cost with increased furnace size is assumed as shown below in Table I.

TABLE I

Furnace diameter, ft	Tons per heat (ingot)	Dollars per gross furnace operating hour* (tap-to-tap)
16	44	$60.00
18	64	65.00
20	88	70.00
22	116	75.00
23	132	77.50
24	152	80.00

*Not including fuel, molds, fluxes or ladle expense.

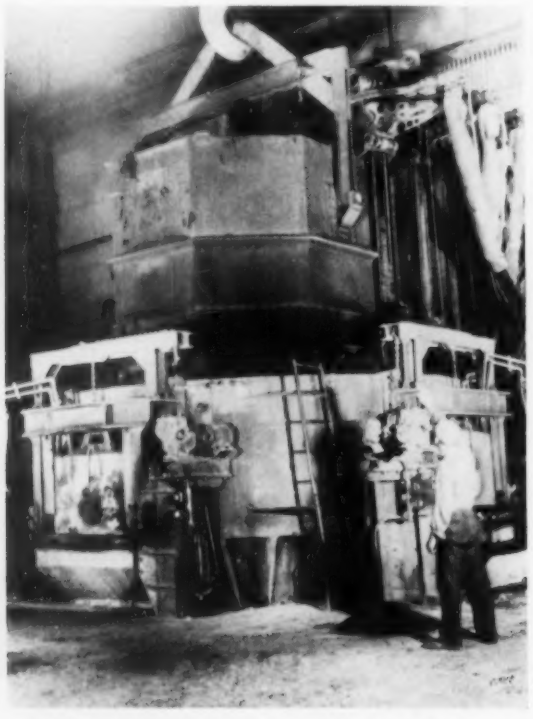
To arrive at total Cost Above figures, the cost of fuel, etc. must be added to the other costs on a per ton basis. We have assumed a cost for fuel, molds, etc. of $7.25 per ton, based on 475 kwhr @ 8 mills, 9½ lb of electrodes @ 18¢ per lb, 6¢ for ladle drying fuel, 38¢ for fluxes, $1.15 for molds and stools and 15¢ for ladle refractories. The other costs can be estimated from the cost per hour figures given above, and the tons per hour (tap-to-tap) figures in Table II. The tons per hour figures are based on our original assumption that, given sufficient transformer capacity, all the different size furnaces listed will be able to make the same number of heats per day. This we have set at 5 per day, i.e., equal to the known average number of heats tapped per day by many 16-18-ft top charge units producing all plain carbon steel.

TABLE II

Operating Cost Above Per Ton of Ingots (Assuming Uniform Heat Times of 4.8 Hours—Tap-to-Tap)

Furnace diameter, ft	Tons per heat (ingots)	Tons per gross furnace hour	Cost above $ per N.T. ingots
16	44	9.2	$13.77
18	64	13.3	12.14
20	88	18.3	11.08
22	116	24.2	10.35
23	132	27.5	10.07
24	152	31.7	9.77

On the basis of these costs, a very considerable saving in cost per ton can be made if we decide to be only half as bold as the open hearth designers and limit ourselves to a 25 per cent increase in heat size. The table shows that a 23-ft shell unit will readily accommodate 25 per cent more metal than the 106-ton heats which are the largest now tapped. This means an increase in furnace diameter of 3 ft or 15 per cent, and would call for an increase in transformer capacity to 30,000-35,000 kva. If the sidewall height of the furnace is increased in proportion to the latest practice on large furnaces, our proposed 23-ft one will have a 9-ft side plate and a volumetric capacity of 3700 cu ft up to the roof ring. Taking 10 per cent less than this for the size of the charging bucket — since there is always a certain amount of bulking or "jack strawing" of the scrap when it falls into the furnace, gives us the bucket capacity we started looking for earlier of 3400 cu ft. This volume can be obtained from a 17-ft diam bucket 15 ft high. Such a bucket holds 55 per cent more scrap than the



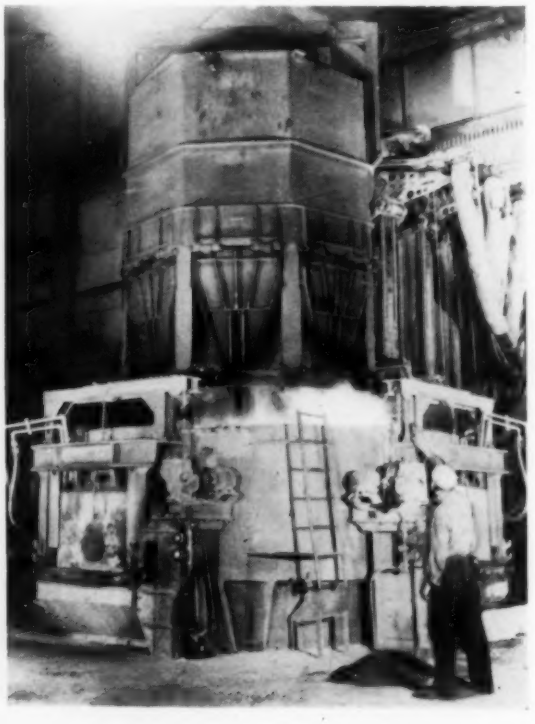


Figure 5 — The bottom opening charging bucket gives fast charging. On left, bucket has been lowered into furnace and on right bucket is being withdrawn from furnace after the tie rope has burnt off and dropped the charge.

2200 cu ft we calculated earlier as the capacity of a drag of charging buggies on its way up the open hearth highline.

This big top-charge bucket would seem to supply a good answer to the design problem we started out to solve — how to cut down charging delays. With the ability to handle 3400 cu ft of scrap in a single container, the speed of scrap charging into the electric will better that of hot metal into the open hearth. Nor will any highline be needed, as an overhead crane is a very efficient way of handling loads of this size.

As between the electric furnace and open hearth, not much can be done about bottom delays; the best we can expect is that the shorter heat times of the electric furnace will minimize them, so that on a percentage basis bottom delays will be proportionately no greater than in open hearth practice. This leaves only the problems of crane and furnace re-building delays to be considered.

About the only way to avoid crane delays would seem to be to supply well built, mill type cranes, of ample capacity for their intended service, and enough of them so that outages will not reduce the amount of crane service necessary for full production. Fewer crane delays will also result if a given crane does not have too many different duties; this means separate building bays and crane runways for the different major melt-shop functions. Our shop therefore should have separate scrap handling, charging and pouring bays, with all ingot stripping and mold preparation to be carried out in separate outside buildings.

From the layout of our proposed "ideal" four-furnace shop, as shown in Figures 1 and 2, it can be seen that ten cranes have been provided in all: four 20-ton scrap yard cranes, three 100-ton charging floor cranes and three 175-ton ladle cranes. We have yet to meet an operator who thought this would not be sufficient.

A further design problem more or less connected with the question of delays is whether to build a ground level or a two-level shop. All modern open hearth shops are of the two-level type, i.e., a charging floor is provided about 25 ft above the ground so that all the work in the pouring and casting bay can be done on one level without the need of pits, which tend to accumulate dirt and are hard to clean while the furnaces are operating. Electric furnace plant design is by no means standardized in this respect, and some fairly recent shops have been built with the furnaces at ground level using pouring pits. The general feeling seems to be however that a ground level shop is likely to have more delays than a two-level one; storage space is also at a premium, unless the furnaces are widely spaced, and such a spread out shop is generally difficult to keep clean. Our layout therefore calls for a two-level shop—i.e., with the charging floor elevated sufficiently so that cinder pot cars can run on railroad tracks at ground level in front of the furnaces, and so that the steel ladles can be filled above floor level. A two-level layout would appear to be almost essential if minimum delay time and a maximum tonnage of ordinary carbon steels is to obtained from high powered fast melting electric furnaces. In short, our solution to the problem of crane delays boils down to a two-level shop with plenty of cranes.

This brings us to the last of our causes of melt shop delay, i.e., interference of furnace re-builds with shop

Figure 6 — The swing roof also expedites furnace maintenance.

output. Here the electric furnace has a considerable advantage in that its roof is completely removable; an old roof can ordinarily be removed and replaced with a new one in an hour's time. Even though an electric furnace roof normally lasts less than half as many heats as an open hearth roof, it has so much less sq ft of roof area per ton of steel that roof relining costs are less than the open hearth's. The total refractory cost of a 13-in. roof for a 23-ft furnace is under $1000, equal to only 10¢ per ton of ingots on the basis of seventy-five heats per roof. Due to the short time required to change a roof, interference with the output of other furnaces is practically nil.

Bottom practice in the basic electric furnace does not differ greatly from that of the basic open hearth; the bottoms of both normally last for several years. The cost of bottom maintenance is therefore limited largely to the cost of the patching materials used after each heat. Since the slag volume in electric furnace operation is ordinarily only about half that used in open hearth practice, and the heats last less than half as long, the consumption of bottom refractories per ton of steel is appreciably lower.

The only rebuilding delay possibility left is the question of sidewall relining. Sidewall life in electric furnace practice varies greatly in different shops, running from 100 to 400 heats, depending upon both the melting and the relining practice followed; i.e., the thickness of refractory used, extent of water cooling, amount of hot patching done, and operating conditions generally. We assume that a modern shop with a reasonable amount of "gun" patching should be able to average 300 heats per complete sidewall relining on straight carbon steel production. For a sidewall relining job, the roof is first removed, and this, coupled with the judicious use of water, cools the furnace off very rapidly. In some shops, a water cooled working platform is used inside the furnace. Actual sidewall rebuilding can usually start within an hour or two after the last heat has been tapped. (Perhaps it may prove feasible some day to remove the whole shell and sidewall in the same way that the roof is now handled. The 100-ton charging floor cranes we

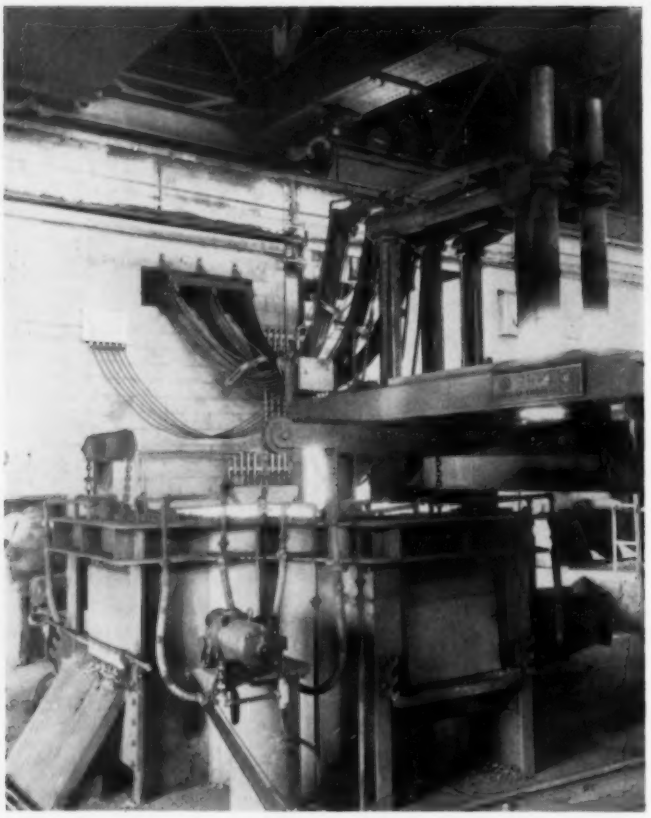


Figure 7 — Furnace shown is another design from that of Figure 6.

propose to use would be capable of handling the 9-ft sideplate and 18-in. lining of a 23-ft furnace.)

The time taken for a complete sidewall rebuild varies in different shops from 10 to 20 hours, depending on the practice followed. At the rate of 5 heats per day, a 300-heat sidewall life means that sidewalls will only have to be rebuilt six times a year; at 15 hours per outage this represents a loss of 1 per cent of a year's operating time. A completely new 13½ in. and 18 in. stepped sidewall on a 23-ft furnace will require about 80 tons of basic brick or $7500 worth at present prices. Assuming that the labor to lay it will increase this to $8000, the cost per ton comes to 21¢, or a total roof refractory and sidewall relining cost of 31¢.

Since the open floor area between electric furnaces is normally considerably greater than in the case of open hearth furnaces due to their greater compactness, ample space exists between furnaces (rather than in front of them) for temporary storage of refractory supplies during sidewall rebuilds. In addition, due to top charging, there are no long strings of buggies being brought in by railroad to be interfered with. In other words the outage of one electric furnace for sidewall relining in no way interferes with the operation of adjacent furnaces. It is thus apparent that the top charging and removable roof features of electric furnace practice almost completely eliminate these two important causes of melt-shop delays.

The above finishes our rather extensive treatment of the matter of delays, during which, in a roundabout way, we have managed to cover most of the main design and operating problems connected with modern electric furnace practice.

Getting back to the question of shop layout, there would seem to be no necessity for the scrap for electric furnaces to come in on cars through the ends of the shop. Due to the large quantity of scrap in a single big charging bucket, it can be handled by crane from the rear of each furnace, as shown in Figures 1 and 2. From these drawings, it can be seen that the scrap is loaded into the furnace buckets directly from railroad cars on a through track in the scrap yard. Two buckets, 17-ft diam × 15-ft high — too wide for regular railroad transport — sit on wheeled platforms on heavy 150-ton railroad track scales under the scrap yard craneway back of each furnace. They are loaded by four 20-ton overhead traveling magnet cranes, one for each furnace. The full buckets then are moved approximately 30 ft to a point where they can be reached by the charging floor cranes.

Two charging cars are also provided for each furnace shop to handle ore, fluxes, deoxidizers and alloy additions. As a matter of good operating practice, it is assumed that four 45 cu ft boxes of heavy scrap (at 150 lb per cu ft) will be door-charged on the bottom before the first bucket of ordinary scrap is dumped in through the top. This 10 per cent or so of machine-placed heavy scrap is to keep the electrodes from damaging the bottom during meltdown and to protect the bottom against the impact of the falling scrap. Under this practice, and with an average scrap density of 40 lb per cu ft, only one initial and one re-charge bucket of scrap will normally be required per 130-ton heat.

One of the major features of our proposed "ideal" layout, therefore, is that the scrap is handled by crane, 70 tons at a time, directly from the scrap yard to each of the furnaces. Some of the other details of the layout shown may also merit brief description.

Two sets of material bins are located at each end of the shop along the common column row separating the scrap and charging bays. These are designed to discharge via weigh hoppers either into charging boxes, or into small buckets for transfer to the big furnace buckets. Large covered dolomite and burnt lime bins at each inner end are filled by means of track hoppers and bucket elevators. Ore, stone, spar, sand, clay, ferro-alloys, etc., can be loaded from containers or by clam-shell by either the scrap yard cranes or the charging floor cranes. Charging boxes of heavy mill scrap, ore and alloys are lifted four at a time by a special cradle from buggies at ground level, and placed on similar buggies on the furnace floor charging track.

The pouring bay, laid out for top pouring of ingot molds on cars, is entirely conventional.

Provision is also made for handling hot metal, 70 tons at a time, by the charging floor cranes from mixer-type ladles which can be spotted at either end of the shop.

Electrodes and refractories complete the list of other major items needed for operation. Refractories are divided into roof, sidewall and ladle brick. Ladle brick storage and ladle relining facilities are at the left end of the shop, while the roof brick and roof relining area is at the other. Sidewall brick are stored under the charging floor towards the center of the shop close to the center hatchway, through which they are hoisted for sidewall repair. Relined roofs ready for use are stored 4 to 5 high in a single tier at the back edge of the

charging floor in the middle of the shop. Electrodes will be unloaded directly from open gondola cars through the center hatch and stored at charging floor level on either side of the tier of relined roofs. The center hatchway is also provided with a roof break-out ring by means of which the brick from burnt out roofs can be knocked out directly into a trash car on the track below.

All storage areas in the "kitchen" under the charging floor are at box car floor level so that palleted brick and other materials can be handled by powered lift-trucks directly from railroad cars to storage, and to the ladle and roof relining areas, without the use of ramps; i.e., everything will be done on one grade, box car floor level.

The 4-furnace shop as laid out should have an assured capacity of close to a million tons per year. An estimate of its capital cost is summarized in Table III. Since the use of purchased power is assumed, no funds are provided for the 80,000 to 90,000 kw of generating capacity required for its operation.

TABLE III

Capital Cost of 4-Furnace Electric Meltshop

Buildings—complete with foundations	$ 1,995,000
Furnaces—erected, including transformers and foundations	2,980,000
Cranes—4 scrap, 3 floor and 3 ladle, installed	2,535,000
Charging equipment—two 7½ ton machines, plus bins, track hoppers, etc.	757,000
Pouring equipment—iron and steel ladles, cinder pots with cars, relining stand, etc.	286,500
Utilities—water, sewers, lighting, railroad trackage, etc. (within buildings only)	191,000
Electrical substation—main transformer, switchgear, circuit breakers, etc.	1,440,000
Miscellaneous—dolomite slingers, magnets, storage racks, power lift trucks, etc.	110,000
Total	$10,294,500
Engineering, construction supervision and contingencies	1,029,500
	$11,324,000

The $11,324,000 given in the above table is only about half the cost of a new open hearth shop of the same capacity, if both estimates are limited to the cost of the facilities listed. It should be noted that the list does not include the cost of a stripper and stripper building, mold yard and cranes, office and locker building, water pumping station, railroad rolling stock and molds, items which are all necessary for steelmaking but which are common to both types of shops. Under existing inflationary conditions, cost estimates are unfortunately subject to considerable error, but it is believed that the "ideal" shop as shown and described herein could be built on the basis of February 1951 costs for the figure given.

GENERAL DISCUSSION

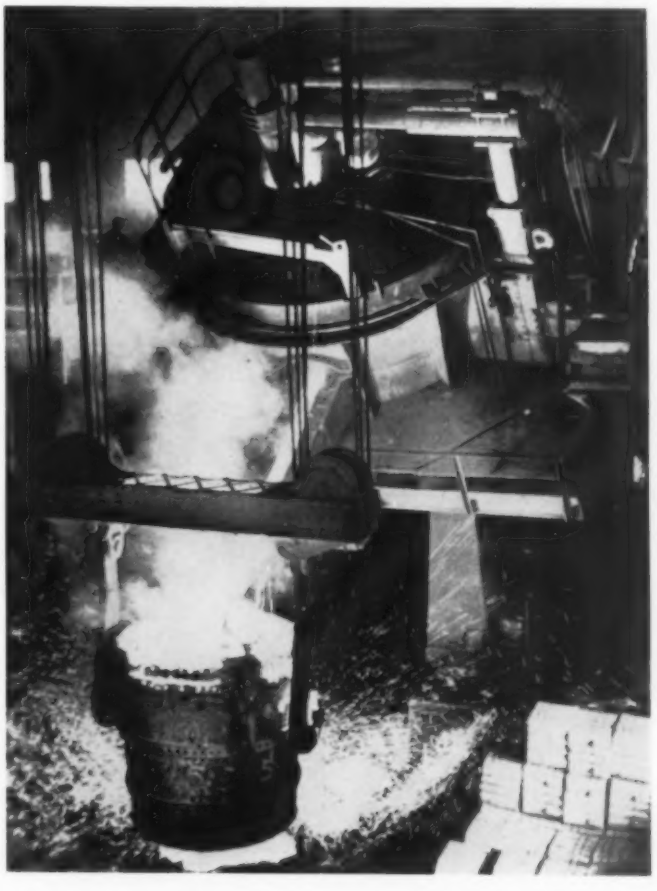
Having laid out our ideal plant and estimated its cost we are now in a position to discuss somewhat more intelligently the question of "Electric Furnace or Open Hearth?" which we have used as the title of this paper. The matter of capital costs having already been covered, perhaps we should analyze the basis of our production cost estimates a little more thoroughly than we have done so far.

Table II estimates that the four 23-ft furnaces of our ideal shop will be able to produce steel for an average Cost Above of $10.07 per net ton of ingots. This figure is based on a number of assumptions the background of which will now be discussed.

The fuel cost figures, 475 kwhr and 9½ lb of electrodes per ton, are based on the average practice which we believe our proposed 4-furnace shop will be able to reach — assuming present prices and wages — if it were to be built. The estimates of 495 kwhr and 11 lb are probably about the best figures now actually being obtained by any existing carbon steel shop using conventional melting practice. Our slightly lower power usage is expected to result from reduced loss per unit of output of a 23-ft furnace compared to 16 to 20-ft ones. The drop in kwhr will also reduce electrode consumption slightly, as the latter is partly determined by the amount of power used.

The main savings in electrode consumption, however, are anticipated from the expected shorter heat times (less time for oxidation), the smaller surface per unit of power input, and the better current carrying ability of 24-in. compared to 20-in. electrodes. Past experience with furnaces 15 ft in diameter and over indicates that electrode consumption decreases, the larger the electrode diameter; one good sized shop cut consumption by 2 lb per ton when it changed from 16 to 20-in. electrodes. It is felt that the combined effect of less delay time, lower kwhr per ton, faster heats and larger electrode size will eventually drop electrode consumption to around 8 lb per ton, or 3 lb better than the best current

Figure 8 — Tapping the electric furnace.

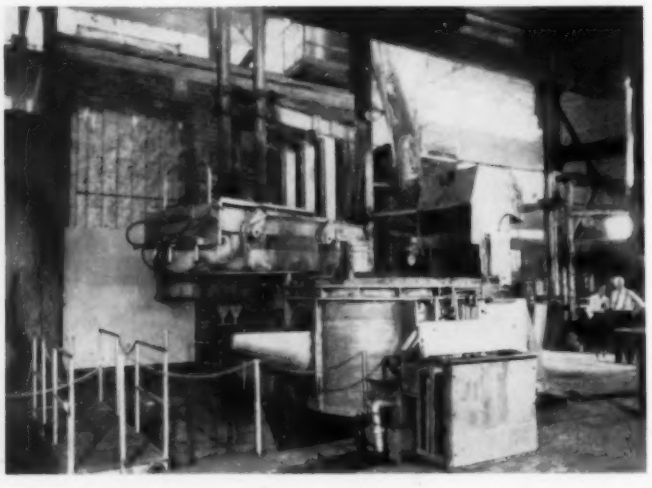


single slag carbon steel practice. In our fuel cost calculation, however, we have been content with half this saving, or 1½ lb per ton, thus arriving at the 9½ lb per ton figure we have used.

The rate of power input determines to a large extent the tons of steel which can be produced from a given furnace per hour, and a study of the thermal values involved is useful in giving us a better understanding of the various factors involved. The actual heat in molten steel (plus an accompanying 5 per cent of molten slag) can be taken at 1,250,000 Btu per net ton of molten metal in the bath at tapping temperature (3000 F) or 366 kwhr. The heat evolved by oxidation of C, Mn, P and some iron reduces this to about 335 kwhr, which however in turn is raised again to 344 kwhr per ton of ingots if the ingot yield from molten metal is taken into account. This 344 kwhr per ton of ingots figure represents essentially the heat in the metal and slag, and is therefore constant regardless of the furnace output rate.

The heat lost in the cooling water and by radiation from the furnace shell on the other hand, is more or less constant per unit time, so that if the output in tons per hour from a given furnace were to be doubled, the power required to supply these latter losses would be cut in half. In other words, if the radiation plus cooling water loss on a 20-ft furnace making 15 tons of steel per hour with a power consumption of 500 kwhr per ton is 20 per cent, the total of such losses per hour amounts to 0.20 × 500 × 15 or 1500 kwhr per hour or 100 kwhr per ton. Now if the output of the furnace, due to better shop layout and design, reduced delays, and higher transformer capacity, is increased to the 18.3 tons per hour figure that Table II gives for a 20-ft furnace, the loss per ton would drop to 1500 ÷ 18.3 or to 82 kwhr per ton — a direct saving of 18 kw. Similarly for the 23-ft furnace, even though we increase the hourly loss by 30 per cent because of its greater surface area or to 1950 kwhr per hour, the loss at an output of 27.5 tons per hour drops to 71 kwhr per ton, a further drop of 11 kwhr, or a total saving of 29 kwhr per ton. Considerations of this sort further confirm us in our belief that our figure of 475 kwhr per ton of single slag carbon steel is conservative for a large modern electric meltshop.

Figure 9 — Dust control is an important factor in electric furnace operation.



The same general method of calculation may be used to investigate the feasibility of the tons per hour figures given in Table II for the larger size furnaces. For instance, the table gives an average output of 27½ tons per hour for a 23-ft furnace. As a basis for comparison, let us use the 20-ft furnace powered with a 15,000 kva transformer and producing 15 tons per hour considered previously. According to Table I it should tap 88 ton heats, and at 15 tons per hour this means a heat every 5 hours and 52 minutes on the average, including delays. If delays are taken at 15 per cent, or 53 minutes, the net heat time is 4 hours and 59 minutes. Assuming it takes 1 minute per box to charge 102 tons of scrap and other materials at an average density of 100 lb per ft in 35 cu ft charging boxes, the gross heat time can be divided up with reasonable accuracy as follows:

Charging (door)	0:58
Melting	2:41
Refining	0:45
Tapping and fettling	0:35
Delays	0:53
Total	5:52

The power required merely for melting the metal and slag is found by multiplying the tons in the bath (after melting) by the 344 kwhr figure just developed earlier. This is equal to:

$$\frac{88}{0.975} \times 344 = 31{,}000 \text{ kwhr}$$

Similarly, the water and radiation heat loss is equal to 1500 kwhr per hour × 2.68 hours, or 4000; adding this to 31,000 gives 35,000 kwhr, which in turn can be taken as equal to 95 per cent of the actual total required power input during melting. (The 95 per cent represents an allowance of 5 per cent for electrical and waste gas sensible heat losses during the meltdown period.) This gives a total consumption of 36,900 kwhr over a period of 2.68 hours. At an assumed average meltdown power factor of 83 per cent the average load on the 15,000 kva transformer would be 16,580 kva or 10 per cent over its rating.

In a similar manner, by working backward we can estimate the rate at which power would have to be supplied to our 23-ft furnace for it to maintain an output of 27½ tons per hour. An average production rate of 27½ tons per hour on a 23-ft furnace tapping 130 ton heats is equivalent to an average heat time of 4 hours and 48 minutes. This can be divided as follows:

Charging (4 boxes plus 2½ top charges @ 6 minutes each)	0:19
Melting (assumed)	2:30
Refining	0:45
Tapping and fettling	0:35
Remainder (=13½ per cent available for delays)	0:39
Total	4:48

Calculating as before:

$$\frac{130}{0.975} \times 344 = 45{,}800 \text{ kwhr}$$

$$1500 \times 130\% \times 2\tfrac{1}{2} \text{ hr} = 4{,}880 \text{ kwhr}$$

50,680 kwhr, which is equal to 95 per cent of the total required power input

during the 2½ hour melting period. The average demand (using a slightly lower power factor of 78 per cent because of the heavier load) is then:

$$\frac{50{,}680 \text{ kwhr}}{95 \text{ per cent} \times 78 \text{ per cent power factor} \times 2\frac{1}{2} \text{ hr}} =$$

27,400 kva

To be on the safe side, let us establish the transformer size for our 23-ft furnace on the basis of 85 per cent utilization instead of the 10 per cent kva overload just calculated in the case of the 20-ft 15,000 kva furnace. Dividing 27,400 by 85 per cent gives 32,200 kva. A 35,000-kva transformer will therefore be ample, while a 30,000 kva will be big enough, if we can reach 89 per cent of full rating instead of 85 per cent.

The above calculations have been made to indicate the feasibility from the power point of view of making 5 heats per day on a 23-ft furnace. The fact that many of the latest 20-ft units now being installed will be equipped with 25,000 kva transformers indicates that the importance of ample transformer capacity for fast melting is beginning to be recognized.

Maximum meltdown voltage has steadily increased over the years as transformer capacities have gone up, in order to keep amperages within the current carrying capacity of the available graphite electrodes, as well as to keep the physical size of the transformers themselves within reason. Taking the rated maximum current carrying capacity of 24-in. graphite electrodes as approximately 50,000 amp, the full rating of a 35,000 kva transformer can be obtained down to 405 v, or for a 30,000-kva unit down to 347 v. These meltdown voltages are just about within the top range of current practice, as at least one 25,000-kva unit now operating has a top of 445 v. In going from 25,000 to 35,000 kva, the top voltage would probably have to be increased to 550 v.

Electric heat is so costly that any reduction in the amount of it required to produce a ton of steel will lower the Cost Above much more sharply than an equivalent fuel saving in the open hearth. While we are considering the subject from the thermal point of view, therefore, it may be of interest to take the time to estimate the theoretical saving in heat which could result from the use of hot metal. The energy equivalent of the sensible plus latent heat content of hot metal at the 2500 to 2600 F temperature at which it is charged to open hearths is close to 300 kwhr per net ton. Although hot metal contains much more carbon, silicon and manganese than the ordinary electric furnace all scrap charge, the heat liberated by oxidation of these elements can be disregarded, as the oxidation would probably be carried out largely with ore, in which case the overall heat effect would be small. Using 300 kwhr per ton, 55 per cent of hot metal is equivalent to a net heat input to the furnace of 165 kwhr per ton of charge. In actual furnace practice, the addition of this amount of energy to the charge would be accompanied by radiation, water cooling and electrical losses; assuming an 80 per cent thermal efficiency (of power utilization), the 165 kwhr is increased to 206. This latter figure, divided by the "charge to ingot yield," gives a total saving of heat due to the use of hot metal equivalent to 235 kwhr per ton of ingots, or almost half of the power required in all cold charge practice.

At 8 mills, a saving of 235 kwhr would be worth $1.88 per ton of ingots. In addition, due to the sharply lower power consumption, electrode usage should also decrease markedly. A two-pound lower electrode usage, representing but a fraction of the proportionate drop in power, would raise the total theoretical saving in fuel cost from the use of hot metal up to $2.24 per ton of ingots. On the basis of some recent work, it is further likely that the use of some oxygen would permit a substantial additional reduction in electric fuel cost.

The $2.24 per ton is probably greater than the difference in Cost Above between our $10.07 figure (Table II) and the Cost Above of the best modern open hearth shops. If a major portion of this theoretical saving due to the use of hot metal could be realized in actual electric furnace practice therefore, it would place the two processes on an approximately even basis as far as production cost was concerned, not counting the normally 1½ to 2 per cent higher yield and better deoxidizer efficiency of electric compared to open hearth melting.

This study would be incomplete if the matter of fume and dust control, a factor receiving increasing attention by the industry, were not at least mentioned. In the open hearth, fumes are largely confined within the furnace system and removed by flues. This makes it relatively easy, except for the very large volumes that must be treated, to pass the waste combustion gases with their load of dust and dirt through cleaning equipment before discharging them to the atmosphere.

Since no fuel is burned in the electric furnace, the fumes from it are much more concentrated and the volume of gas that theoretically would have to be cleaned is therefore very much smaller. Unfortunately no simple method of collecting these fumes in concentrated form before they leave the furnace has as yet been worked out. Normally they escape from the furnace doors and leak out around the electrodes into the meltshop building itself. Roof ventilators can be used, but recovery of the furnace fumes from the atmosphere at this point probably would result in the collection of an even larger total volume of dust laden air for treatment than in the case of the flue gas from the open hearth. A great deal more work will have to be done before the problem of fume elimination in electric furnace practice can be said to be successfully solved.

SUMMARY

The main features of a proposed modern top-charge electric furnace steel meltshop designed to produce ordinary tonnage carbon steels at low cost are developed in detail and probable capital and operating costs estimated.

Assuming the availability and use of purchased power, the data presented indicate that such a shop can be built for approximately half that of an open hearth shop of equivalent capacity, and that with 8 mill power it could make steel from an all cold scrap charge more cheaply than the open hearth.

It is also believed that such a shop would have an excellent chance of making steel from hot metal and scrap charges at an overall production cost no greater than that of the most modern open hearth plants.

HUMAN RELATIONS

. . . . excerpts from address presented at AISE Annual Spring Conference, Detroit, Mich., April 30, 1951 . . . .

▲ I WANT to discuss the problem of human relationships — relationships which have much to do with increasing the well-being and living standards of America. As Henry Ford II has pointed out, if we can solve the problems of human relations in industrial production, we can make as much progress toward better living in this country during the next 10 years as we have made during the past 25 years through development of the machinery of mass production.

When you speak of mass production you instinctively think of the Ford Motor Co., and to millions of people throughout the world, the Rouge plant in Dearborn symbolizes mass production of automobiles.

But not very many of these people have any idea of the size and scope of that plant. Few realize that the Rouge is a city of its own, with a population of more than 75,000 men and women every working day. The total payroll for this plant in 1950 was more than $306 million, and during the year nearly 140,000 persons came to see the Rouge in operation. The plant area covers 1200 acres, and operations are carried on in 99 buildings, with a floor space of nearly 16 million square feet. It has 26 miles of roadways and more than a mile of docks for our ore boats, which handle more than 3,550,000 tons of ore and coal during each shipping season.

As you can well imagine, such a plant represents many problems, but added to this is the fact that we operate nearly 50 other manufacturing plants, engineering laboratories, test tracks and parts depots. Altogether we employ nearly 150,000 men and women.

With such operations, one of our many vital problems is the health and safety of our employees. Prevention of injuries and disease is one of our major jobs, and our objective is to make the Ford Motor Co. the world's safest and healthiest place to work.

As a result of our constant safety program, our frequency rate involving lost-time accidents in 1950 dropped 60 per cent below the 1948-49 rate, and we are proud of the fact that the accident rate in Ford plants is far below the rate for the automobile industry as a whole. Within the past 12 months eight of our plants have earned the Distinguished Service Award of the National Safety Council for having worked more than 3 million man-hours without a lost-time accident, and our Lincoln-Mercury plant at Metuchen, N. J., established a new record for the company with more than 6,331,000 hours.

Each year our safety department issues more than 3,600,000 pieces of safety equipment, supervises the installation and operation of more than 2000 different kinds of safety guards on machines and equipment, and carries on constant training programs. We strive to eliminate the cause of accidents, believing in prevention rather than cure.

Talking only about dollars and cents, accidents have a direct bearing on costs and production, so it's smart to prevent accidents from a purely business standpoint. From the broader point of view, however, we are not doing a good job of human relations unless we always remember that one of its biggest aims is the protection of the individual.

For in this entire program of human relations, it is the individual who counts. Machines alone do not give us mass production. Mass production is achieved by both machines and men. The human factor is the most valuable asset of any industrial enterprise. Machines, buildings and equipment — all these can be duplicated. But the one element which cannot be duplicated is the unique combination of talent, skill and experience represented by the men and women of an organization working together as a team. This is the human element. This is where human relations begins.

Men have been able to build marvelously complex machine tools. Men have produced superior products. Men have built jet propelled aircraft — machines that fly faster than sound. Men have solved the mysteries of atomic energy. But men have not yet shown themselves smart enough to live together — as neighbors or as nations — in harmony and peace.

It was a part of this problem which Henry Ford II stressed in his widely-discussed talk on "Human Engineering." Now this idea of human engineering is not visionary "do-goodism." It is not a plan to present employees, in paternalistic fashion, with a "heaven here on earth." It is a hard-headed, realistic, business-like point of view.

What happens when we treat an employee as a human being — when we lay stress on the importance and dignity of the individual?

As we see it, this approach can do several things.

It can provide an opportunity for the employee to enjoy a sense of worth-while participation in the overall job — to be identified with the accomplishments of the team. In short, human engineering seeks to provide opportunities for an employee to satisfy many of those normal desires which motivate all of us.

Clearly, the company benefits when the employee benefits — and so will the public benefit through lower costs and better products.

Industry has not always approached its *employee* problems in the same manner in which it has approached its *mechanical* problems, with the result that our lack of human engineering has created waste and inefficiency which handicaps the very purpose of mass production — lower costs.

In a free, competitive democracy, mass production is a tool for raising the standard of living by reducing costs and thereby bringing more and better products within the budgets of more and more people.

Now, you may well ask: "What has human relations got to do with reducing costs?" I would like to answer that question by giving you my definition of human relations as a program for industry: Human relations embraces all the things we do to attain mutual understanding between ourselves and the men and women

IN INDUSTRY. . . .

By R. E. ROBERTS
Manager of Employee Relations
Ford Motor Co.
Detroit, Mich.

who are our *employees*. Unless we have that mutual understanding we are not going to have the teamwork so necessary to reduced costs.

Too many people have failed to realize that in order to have more we must produce more. It is our firm conviction at Ford Motor Co. that the best interests of the American worker, as well as the consumer and the company, lie in the direction of maximum production and productivity. That is the surest road to low costs and prices and a higher standard of living for the nation as a whole. It is the road to a healthy economy, and it is only in a healthy, prosperous and well-run nation that we can afford the highest possible wage rates and the steadiest possible employment.

I think you will agree that this conviction is especially sound from the viewpoint of the workers of this country. Maximum take-home pay, maximum annual employment — all the things that spell maximum security — can be achieved only when a company is operating under the best possible and most favorable conditions.

Our aim at Ford is a higher real income and greater security for the employee, and higher income and greater security for the company. We must all recognize that wage rates are at best only half the equation. The equally important other half as large production at low costs in order to achieve the largest possible markets, and therefore the largest possible employment.

As we look at this whole problem of human relations, we feel that the solution must be found through mutual understanding between management and the men and women who are our employees. If we cannot succeed through understanding and cooperation, it does not seem likely that we can succeed by any exercise of force. We cannot, for example, expect legislation to solve our problems, for when free men give up the task of trying to get along with each other and pass the task to Government, they surrender a large measure of their freedom.

What is needed today is industrial statesmanship instead of industrial antagonism. The public interest requires that we find ways to eliminate industrial warfare without impairing or diminishing the rights which both management and labor must continue to enjoy. We will always have some honest differences of opinion, but we certainly can deal with these on a more human and professional plane. In this we must have the wholehearted cooperation of responsible union leadership. Union leaders today have the power to affect industrial production on a vast scale, and if they are going to be real leaders they must accept the obligations that go with leadership.

And, speaking of obligations, management has an important function to perform in helping to protect the interests of its employees. It is the function of management to *manage*, and if the people in any enterprise are the most important part of it — as they most surely are — then a primary responsibility of management is to exercise leadership with respect to the men and women who make up the organization. It is a responsibility that cannot be abdicated.

One of our important management responsibilities is to keep our employees informed about WHAT we are doing, WHY we are doing it, and HOW it will affect THEM. A well-informed employee is a better employee because he feels that he is a part of the team.

Not only must we keep them informed about what is going on in the company, but it is vital that the men and women in our company be honestly informed — and able to think for themselves — on other matters in which they may lack personal experience or knowledge of the truth. In fact, to help keep America prosperous and strong, we are in a close race between confusion of the public mind and the simple truth. And it may be later than we think.

Actually the truth is news to most people. There are so many false theories being expounded today that it is essential for all of us to be honestly informed — and on an absolutely non-partisan basis. One of these theories has to do with just about the greatest single asset we have in this nation. It comes under the heading of freedom, and only the American people, in the end, will decide how much they want to give up for the substitutes that have brought nothing but trouble to those countries which we at times seem to be following.

This thing is not easy to define, but let us call it the hope of reward. It is present on every farm, in every store, every factory, every office building in America. It is the mainspring of every man at every lathe, every drill press, on every production line — wherever *free* men work and live.

It is born in every boy who sets up a lemonade stand on Main Street. It was the driving force that built the Ford Motor Co. from nothing but a poor mechanic's dream. It is back of every good and great thing this nation and its people enjoy. It is the motive power, the life blood, the very backbone this country cannot and will not get along without.

For whether our critics here and abroad like it or not — the hope of reward is *profit*. And progress — in the American style — is the goal of profit. All the elaborate economic theories ever dreamed up cannot alter that one simple fact. We are *what* we are, and *where* we are because men have been free here in America to work where they pleased, risk their savings, invest their hard-earned dollars, grow, expand, progress — and never stop.

There are people today who are trying to erect barriers against this incentive of free men by seeking to destroy what they call the PROFIT system. To begin with they should quit calling it what it *is not* and call it what it *is* — a *profit and loss system*. Any schoolboy can tell you that it had better be a PROFIT system if this nation is going to continue to grow and progress and fortify itself against attack. For if the 60,000,000 who now have jobs are going to keep them; if we are going to provide billions of dollars for less fortunate

nations, and if we are going to spend more billions of dollars for armament, then we had better encourage industry to make ample profit — for who else is going to pay for all these things? This is something that concerns every man, woman and child in America.

These are simple truths every employee of every business and industry should know and understand, for they have an important effect upon their jobs, their homes and their families. It is management's responsibility to provide that kind of honest information to the men and women who are its employees as part of a human relations program that will attain this important objective:

To help create a better understanding of the problems of industry in the minds of employees and their families so that our American system of private enterprise may continue to produce more and better goods for more people at less cost.

One of the first steps in such a program is to answer these two questions:

What do *we* expect of our employees?

What do our *employees* expect of us?

There is nothing complicated about the answers.

Management wants:

Good workmanship.

Loyalty and teamwork.

A fair day's work for a fair day's pay.

Our employees want:

Security — A feeling of reasonable certainty about the permanence of his job.

Opportunity — A chance to better his lot in life through promotion and higher earnings.

Understanding — A feeling that what he does is important, and that he is appreciated. A desire to be kept informed; to know something about the company's plans and how they will affect him.

An effective program of human relations should provide the common grounds upon which the wants of both management and employees can be realized. As we have pointed out before, we feel this job can be done through understanding and teamwork between management and employees. We in Ford Motor Co. believe that an important step in that direction is to obtain an accurate determination of what our employees really do think and really do want — not what someone else tells us they think and want.

To help get these answers we make use of employee attitude surveys, the kind which permit our employees to take down their hair, so to speak, and tell us what they think of us, and to make constructive suggestions as to how we can improve our policies. So far as we are concerned we want straight answers. To date we have learned some very interesting things about ourselves — and not all of them complimentary by any means. We publish these opinions, the good with the bad, so that all of us can learn something from these surveys.

We believe good human relations depend on understanding, and understanding depends on communication. But communication is a two-way proposition. It isn't all telling. There has to be lots of listening. In other words, a two-way flow of information is vital to the success of any employee relations program.

In our efforts to attain that objective we are making use of a wide variety of tools, and one of the most important of these is communications. We have 25 plant newspapers which are mailed to the homes of our employees, thereby reaching an audience of nearly half a million people. One of these papers — the Rouge News in Dearborn — has a weekly circulation of more than 92,000. The objective of these papers is to keep our employees informed of *what* we are doing, *why* we are doing it, and *how* it will affect *them*. A well informed employee is a better employee.

We have monthly news letters for our 35,000 salaried employees, and a special Management Information Bulletin which goes to more than 8500 members of supervision through our teletype network which reaches every plant, parts depot and sales office in the country. We consider our foremen an essential part of management and we are trying hard to provide him with all the tools he needs to be a good manager. We went through the unhappy experience of trying to deal with organized foremen and everyone concerned found it just would not work.

We have a monthly management meeting program for all supervision which requires 600 meetings a month throughout the country. A management development program covers every foreman in the company. This is essentially our training program for supervision, and it also trains hourly-rated men to become foremen. All our foremen come from the ranks, and it is from this group that future executives of Ford Motor Co. will be chosen.

We utilize suggestion plans for both foremen and hourly-rated employees, and we also solicit their ideas and suggestions through question and answer programs. As I mentioned previously, we place great stress on our health and safety programs, and we also conduct extensive recreation programs. We believe in getting our employees and their families together in family parties and plant visits, and one of our most successful ventures is the program which brings children of employees to our plants for a day of recreation, entertainment, and a visit with Dad on the job. We have been experimenting with a new project which brings a selected number of wives of employees to the plant for luncheon and a visit with their husbands on the job, where they can be shown at first hand all the things we do to make their husband's job as safe as is humanly possible. The reactions to this idea have been excellent. When we are ready to present a new model car, we have special previews for employees and their families before they are shown to the general public.

We also utilize such other media as letters to employees, supervisory and employee handbooks, service awards, bulletin boards, posters, movies, radio, booklets — in short, we are trying to make use of every form of communication possible. A personal touch is added by Henry Ford II at Christmas when he sends a personal telegram to each of our more than 8500 supervisors, and writes a personal Christmas letter to every employee and his family.

Right here I would like to make one point very clear — please do not get the impression that we consider ourselves better or more progressive than anybody else. We have learned a great deal from others and many of the things we are doing are being done by other companies. We realize that we have a long way to go, and we are trying to build on a firm foundation. Mr. Ford has described our position in these words:

"We would like to have you think of the Ford Motor Co. as the kind of a company that has an interest in people because we think great things may come out of work in the field of human relations."

Which brings me to this important point: Public relations cannot be brought into the plant or plant community from outside. It must begin *inside* the plant. For it is very obvious that if we do not have good relations inside our plants we cannot have good relations outside our plants. In other words, if you do not have good *employee* relations, you will never have good *public* relations.

But when we do the right kind of a job with our employees — when we treat them as human beings and not just badge numbers — they, in turn, will do a public relations job for us by telling their friends and neighbors that Ford is a good place to work, that we are fair and understanding people, and that we make a fine product. The end result will be that the good relations we have created inside our plants will expand into the homes, the community and the nation. This is where public relations begins.

Based upon the precept that "What is good for the community is good for us, and what is good for us is good for the community," we believe in being a good neighbor in the plant community in which we live. We believe we have a civic responsibility in our plant community because of our entity as an important contributor to its industrial life. In so doing, we will find that our employees not only have pride in their jobs, but also have pride in the company for whom they work.

What we have described here might be termed the framework for a program of human relations. There are no miracles required to make it work. It is just a common sense application to a human problem of the same formula we have always applied to our mechanical problems. It requires leadership and initiative.

Such leadership must come from the heads and hearts of every one of us in American industry. It must be put to use by the devotion of an ever increasing proportion of our time and energy to the problems of the individual.

We in the Ford Motor Co. believe in the individual and we look upon human relations as a road to greater security for the whole enterprise, and therefore, greater security to the individual. We see a great need for helping the individual to understand just what security really is. For too many people are crying for security today without knowing quite what the word means. Just when is a man secure?

There are times in history when men thought security was a physical thing, such as the Chinese wall, the Maginot line, the airplane, the atom bomb. History proves that these are not and never were security. Other men have said "security is a law. If we could only get a law passed there would be no more trouble." But laws can change overnight and do. There are others who say that security is money. "If only we had money, we would have no fear." But money can be lost. Inflation lowers its value. Another says that "security is a contract." But who among us can contract to be alive tomorrow? Probably the most vicious definition of security is that which insists it comes with political power. It is vicious because it can affect entire peoples, whole nations, even the course of history.

Too many are tempted today to turn back to the philosophy our forefathers abandoned when they fought the Revolution — the idea that man must look to Government for a solution of his problems. Too many forget that Government itself produces nothing. Government is only another man, or a small group of men, fully as insecure and beset with doubts, fears and selfish ambitions as the very men who look to them for a solution of their problems.

Security is none of these things. Security is in the hearts of men who have faith in themselves as individuals; who believe that progress comes through individual enterprise and individual responsibility; men who realize that security comes through helping their employer achieve the strongest possible position with the consumer by turning out better products at lower cost; men who have the courage, the personal integrity and the love of freedom to build security out of their own strength. For no employee can expect security from an insecure employer. There are forces in the world today dedicated to the theory of class struggle and devoted to the principle that men can be divided into hostile groups. In the face of this, we in America cannot hope for security — either individually or as a nation — unless first we attain that human understanding which will enable us to recognize each other's problems and work together for our mutual interest.

That kind of human understanding can be achieved if management will make an honest, thorough-going effort to tell its story openly and without any "angles." If management does this it can gradually build up interest and confidence in what it says and does. And if employees learn they can rely on what management says, they will be far better able to judge issues fairly and competently.

For if we can make it very clear to our employees that the only way to higher standards and real personal security is through more and better production at lower costs; that they stand to gain most from greater productivity; that technological improvements create jobs rather than eliminate them, then we need not worry that they will be deceived too long by false promises.

To sum it up in the words of Del Harder, our vice president in charge of manufacturing: "This, then, is what I believe to be our job: to increase our efforts to achieve greater production at lower cost, to earn and maintain the confidence and cooperation of our employees, and to help bring about a better understanding among employees and the public of what industry stands for and how it operates."

That is one of the important objectives of our Human Relations program, and I can think of none more important than the task of renewing and strengthening the faith of our people in private enterprise and individual freedom.

This has special meaning for us, right now. If we expect to find the right answers to the grave problems we face today, we must dedicate our hearts, minds and spirits to the search for truth, not only as citizens of our nation, but as citizens of the world and members of the human race.

If we succeed — and we must succeed — the result will be that we will help to preserve and strengthen the American way of life in which we believe.

The Continuous Merchant Mill

By L. C. SOWELL
Superintendent, Blooming and Rolling Mills
Jones & Laughlin Steel Corp.
Aliquippa, Pa.

. . . . it is debatable whether the straight-away continuous mill or the semi-continuous cross country mill is the more efficient production unit . . . .

▲ AT Aliquippa, we are inclined to favor the straight-away continuous mill. This is exemplified in our 21 & 18-in. billet and bar mill, our 10-in. skelp, and our 14-in. merchant mill. A mill of this type has many advantages over other type mills in spite of some limitations on the kind of product that may be produced. In designing a mill, it is necessary to take into account many factors, but the class of product to be produced is of prime consideration. The major portion of this paper will deal with a discussion of our Aliquippa straight-away 14-in. continuous merchant mill, with some mention made of our No. 18 (14-in. semi-continuous cross-country mill located at Hazelwood). However, due to limited space, it will be necessary to deal in generalities rather than in details.

The Aliquippa mill is of our own design, and was erected in 1924. We believe it was the first continuous mill to roll shapes. The erection of this mill was the result of a dream of one of our top officials, a son of one of the original founders, and was erected primarily to produce junior beams. However, the design was also predicated on the production of such standard products as angles, channels, flats, and other special sections desired by the trade. This mill has a possible delivery speed of better than 3200 fpm which was an innovation at that time for a merchant mill. More than an adequate requirement of power was provided on mill stands. Particular attention was paid to the versatility in the sections to be produced. The roll train itself consists of 12 stands with a 13th stand replacing No. 12 stand when rolling junior beams. This stand is of special design, and after many improvements it does a very good job. It carries 30 in. horizontal driven rolls and 18 in. friction driven vertical rolls. The three roughing stands are gear driven as a single unit, having 16-in. pinions and roll diameters slightly in excess of that figure.

The intermediate, the leader, and the finishing stands are normally driven by 14-in. pinions. However, in some cases on small light sections, 16-in. pinions and larger diameter rolls are used on the leader and finisher.

The edgers, which are No. 4, No. 8 and No. 10 in the line, use approximately 18-in. diameter rolls, and are bottom driven. Recently roller bearings have been installed in the drives at a cost exceeding a $100,000 expenditure. Weekly inspection of these drives at a minimum cost is made as to wear and lubrication.

All stands, with the exception of the three roughing mills, are individual driven directly off the motor. Speed control and screwdown adjustments are easily handled from a well-located pulpit adjacent to the mill. Air operated loops are also located in this pulpit. These loops operate in the up-position rather than the down-position because it gives the mill operator a better view and control of the material going through the mill.

All mills are provided with an electric driven screw-down. Up and down movement of trough and guide adjustments on edging mills are electric driven. Spare housings are provided and are built up on the mill floor ahead of any mill change. This of course decreases mill down time and reduces costs.

Two electric driven screw-downs are provided on the mill floor, and mill settings are adjusted and checked before the housings are set in the line. All changes are made very quickly, a complete mill change having been made in a minimum of one hour and fourteen minutes. Jump changes are made in seconds, and pass changes in minutes. However, the critical attitude of the trade necessitates a close check of section which actually consumes more time than the change itself.

Guides on this mill are of extreme importance in that most sections are made in open passes, and for this type of rolling, many dimensional changes are accomplished by guide adjustment. This necessitates guides designed for quick accurate adjustment and rigid stability. For lightweight, irregular shapes, guides both entry and delivery must be made to accommodate fast moving bars and enter the bar into each succeeding stand without any hesitancy as well as help keep the delivery of the bar in the narrow troughs between the mills.

Any appreciable hesitancy on the bar entering a pass will cause a high loop and probably one or more cobbles because more than one bar may be in the mill at the same time. Much money and effort has been placed in

acquiring well designed guides for this mill, and it is a continual problem.

Angle rollings are split into two ranges, i.e., large angles and small angles, and four groups governed by leg length. The term large angles as we apply it covers a range from a 3-in. leg up to and including a 5-in. leg. Small angles cover the range including a 3-in. leg down to a 1½-in. leg. Therefore a 3-in. angle may be rolled in the large range or the small range.

The four groups constitute:

1. The large equal leg angles, i.e., 4 × 4 in. down through and including 3 × 3 in.
2. Large unequal angles constitute the range from 5 × 3½ in. down through 3½ × 2½ in.
3. Small equal angles from 3 × 3 in. down to and including 1½ × 1½ in.
4. Small unequal leg from 3 × 2½ in. down to 2 × 1½ in.

Angles are made in all standard gages. Special sizes or thickness can be obtained on inquiry. The 3 × 3 × ⅛ in., a difficult section on most mills, is one of our specialties.

The advantage of this grouping can be easily seen in the small amount of roll changing necessary as shown below:

Mill going from large equal leg angle group 1 to large unequal leg angle group 2; change No. 8, 9, 12, one edger and 2 horizontals. Change time is 45 minutes.

Mill going from large unequal leg angles to small equal leg angle group No. 2 to group No. 3, change 9 stands — ten in use, No. 1 which has flat rolls is not changed. Change time is 1 hour and 40 minutes.

Mill going from small equal leg angles to small unequal leg angles No. 3 group to group No. 4, change No. 8, No. 9 and No. 12, one edger and 2 horizontals. Change time is 45 minutes.

No other roll changes are necessary for the numerous sizes and gages covered in the above groups.

This mill rolls flat-rolled products from 1½ in. in width up to and including 15 in. wide, in all thicknesses ranging from 3/16 in. up to a standard thickness of 1½ in. Thicknesses, however, can be produced up to 3½ in. upon special inquiry. To cover the wide range in width changes on flat-rolled products, a special screw-adjustable guide is used on the last three horizontal stands No. 7, No. 9 and No. 12. This reduces change time considerably.

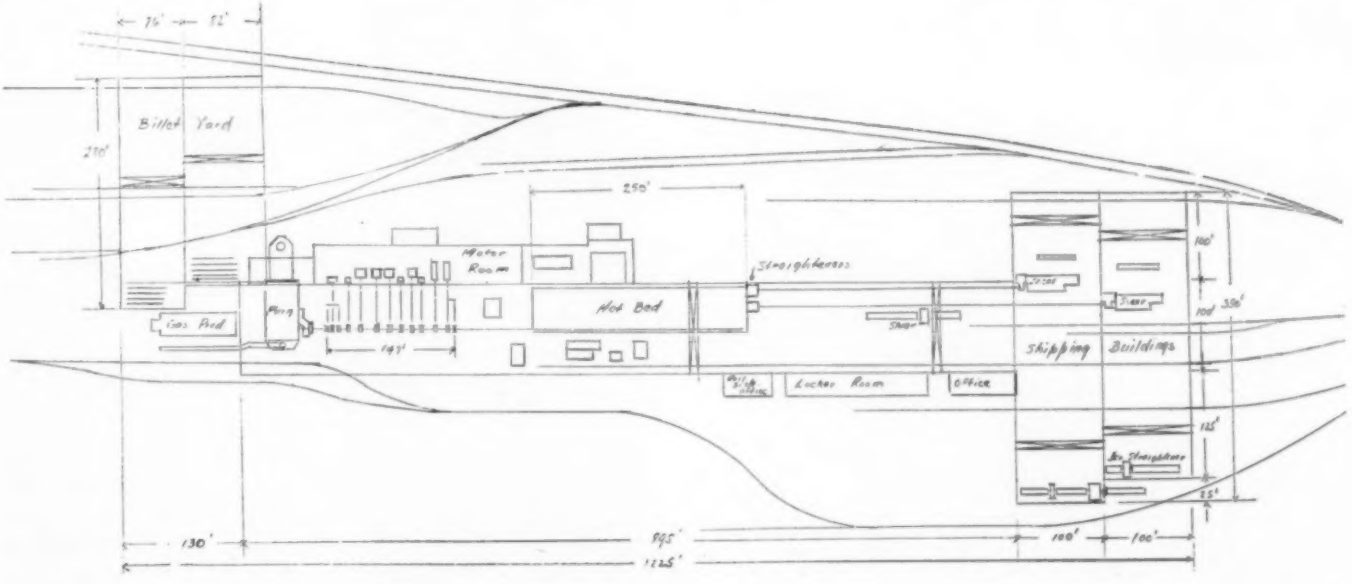
Flat-rolled products are classified into four groups according to thickness and width. From ⅝ in. down constitutes one group, and requires an edging mill roll change going to the next group which covers the thicknesses exceeding ⅝ in. The split on width occurs at 8 in., but no rolls are changed except in case of firecrack, wear, or breakage.

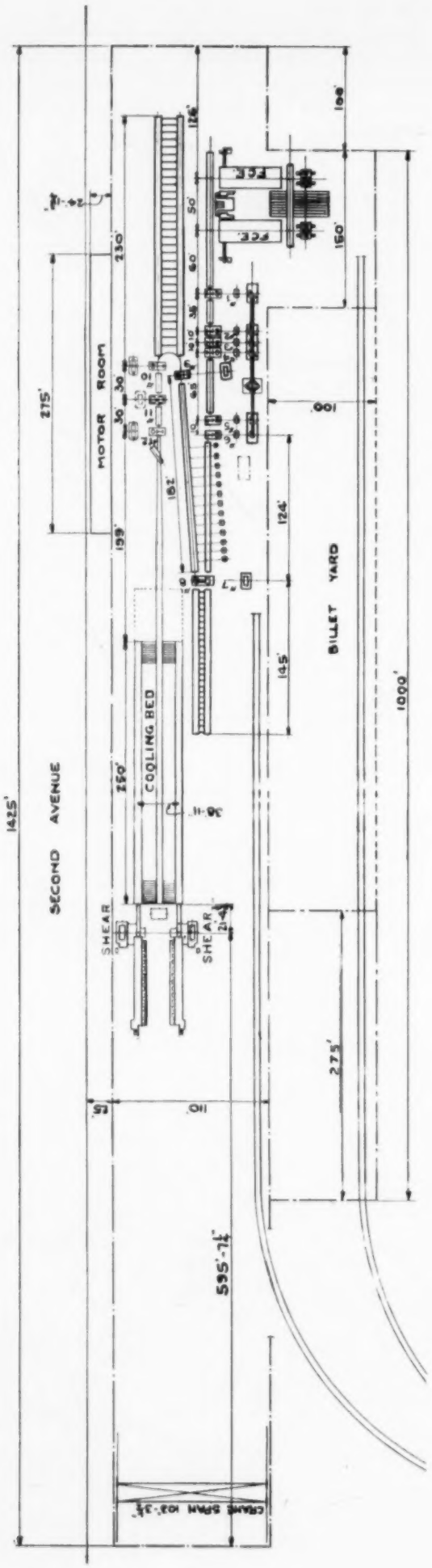
Our roll designers together with the mill supervision have made extensive studies, and reduced the amount of equipment change and the lost time involved to a minimum.

As has already been pointed out, this mill is very versatile as to sections produced. Although this is a 12-stand mill, we very frequently find that we are able to produce the desired section in eight passes. The fact that we only have one billet mill, and it at present overcrowded with numerous sections for our various mills, frequently necessitates the 14-in. mill to make its own billet size for some particular section. This is done in the first four stands, which is of course, three horizontals and one vertical. A checkup in recent years indicates that we have produced slightly over 3300 sections for over 1500 customers within a yearly period. Considering the wide range of products produced on this mill, we have been able to confine our billet sizes to an approximate figure of fifteen.

Furnace condition has also been a contributing factor in limiting billet sizes. At present, our smallest billet is 2 1/32 × 2 1/32 in., and in a distance of 53 feet of travel down the furnace slope even with a drop of ⅞ in. per foot, one can readily see the trouble that may be encountered if conditions are not favorable both as to quality of billet section and furnace bottom conditions. We have at times, on fast orders, rolled as high as 370 — 2 1/32 × 2 1/32 in. billets per hour.

Figure 1 — Layout of 14-in. continuous merchant mill at Jones & Laughlin Steel Corp.'s Aliquippa works.





Billet yard conditions are also of prime importance in that various grades or analysis, billet size, length, etc., require numerous separations, and reduces the efficiency in stocking.

A mill of this type, on a monthly production of 25,000 tons of product, requires an inventory of from 8000 to 12,000 tons of billet stock. Thus we see the importance of a minimum number of billet sizes.

The design of the cooling bed is also of prime importance to the successful operation of a merchant mill. This cooling bed is of the flat type with a shuffle bar and gathering device movement which is adaptable to our versatile type of products.

Another innovation in the design of this mill was the placement of two straighteners in the line of material travel at the end of the cooling bed which enables us to straighten the material directly off the mill in hot bed lengths. This requires considerable experience on the part of the operator in that appreciable re-straightening is necessary after shearing if the job is not handled properly. We believe this mill is the first to adopt this setup, and the tremendous saving in cost involved can readily be seen were it necessary to straighten the short bars after they are sheared and allowed to become cool. This feature also enables the mill to give a much quicker delivery to its customers in that material can be loaded directly from the shears into cars.

The assembly and shear approach tables and the shears require no special comment. However, the design compares favorably with any mill in the country.

The bar pilers were, and still may be classified as another innovation on this mill. They have both the lateral and vertical movement, and enables us to nest all material except the $1\frac{1}{2} \times 1\frac{1}{2}$ in. angles as they are cut.

We are also in a position to make what we term split lifts, that is, where customers require special piling, of so many bars wide and so many bars in height. This feature is very important in relation to mill costs and quick delivery to our customers.

Our finishing end or warehouse requires no special mention except that it consists of two cross bays served by four overhead electric cranes (two in each bay), and is considered one of the limiting features of the mill in that insufficient space has been allotted. This, coupled with our limited heating capacity, can be considered the most serious bottlenecks within this unit, and were the ingot capacity available, justification for this improvement could be presented, and the present capacity of this mill practically doubled.

Another important feature is the fact that with the type of product produced on this mill, our salvage of material is very high, giving us a very good overall yield (a record monthly yield of 95.04 per cent and record yearly yield of 93.06 per cent). We believe our book record and method of identification down through the mill to be of the best in that very few mixed steel cases occur, and this speaks well for a mill of this type

Figure 2 (left)— The products rolled on the No. 18 mill run from $1\frac{1}{32}$ to $4\frac{1}{32}$ rd; $^{29}/_{32}$ to $2\frac{1}{2}$ in. sq; $1\frac{1}{8}$ x $\frac{7}{8}$ or $1\frac{1}{4}$ x $\frac{5}{8}$ to $3\frac{1}{32}$ x $2\frac{1}{8}$; die roll shapes; $1\frac{1}{32}$ hex to $2\frac{5}{8}$ in. hex; diamond bar (concrete bars); and miscellaneous shapes.

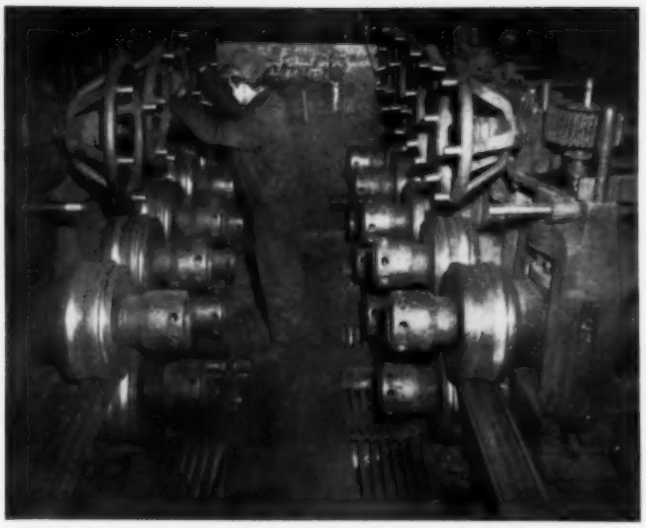


Figure 3 — Two modified straighteners are in service at the Aliquippa 14-in merchant mill.

handling the numerous items it does on sizes, lengths, and analysis.

In closing, we would like to point out some of the advantages and disadvantages in this straight-away continuous mill as compared with some of the other type mills, in particular No. 18 mill at the South Side. A study of the records would indicate that the change time should be, and is about the same. There, however, is some difference in versatility in that in the case of the cross-country mill, the bar may or may not be in more than one stand at a time, whereas, in the straight-away continuous mill it may be in many stands. In the case of the cross-country mill, a check of section can be more easily made between stands, whereas in the straight-away continuous mill it is necessary to throw out cobbles which of course is costly in time and material.

In the matter of finish, the cross-country mill has a distinct advantage in that temperature and finishing conditions can be more readily controlled. In the matter of rolling rate and overall cost, we believe, with bottlenecks eliminated, the straight-away continuous mill has a distinct advantage. Once a straight-away continuous mill is set up on a section, it becomes a matter of close attention and watching of bar travel and checking of section; the remainder is merely routine.

Theoretically, the continuous mill is subject to more cobbles and a slight increase in steel loss over the cross-country mill. Actually it requires a straighter and truer delivery from stand to stand.

Maintenance and utilities costs which are very vital to all operating units appear to be about equal.

A comparison of rolling rates, which is one of our most important cost comparison controls, is given in Table I:

Figure 4 — Other side of modified straightener.

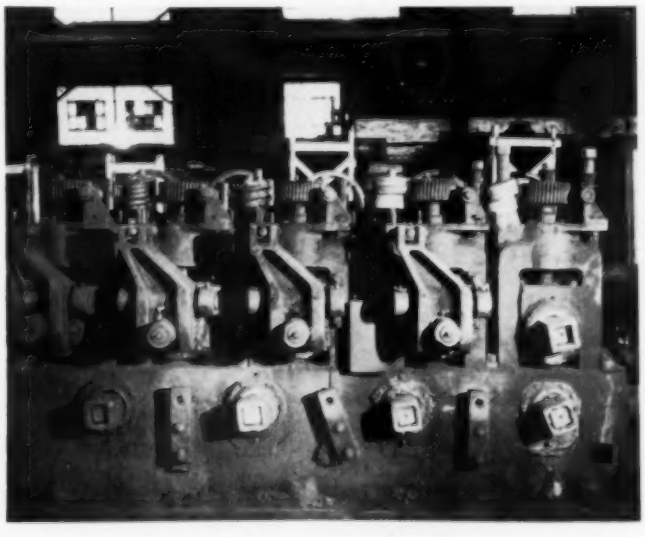


TABLE I

	14-in. Rolling mill— Aliquippa		No. 18 Mill— South Side	
	Rolling rate	Average ft wt, lb	Rolling rate	Average ft wt, lb
Best month	55.72	4.917	72.52	9.415
Best year	45.27	5.271	65.15	8.572

A few of our production records will no doubt be of interest and are therefore listed in Table II and Table III.

TABLE II

	Aliquippa— 14-in. Mill (net tons)	South Side— No. 18 Mill (net tons)
1 Hour	122	155
8 Hour	735	1,235
24 Hour	1,992	3,370
Week	8,167 (18 turn)	11,765 (20 turn)
Month	30,522 (18 turn)	44,125 (20 turn)
Year	290,687 (18 turn)	457,947 (20 turn)

TABLE III

Commodity Production Records

Section	14-in. Mill— Aliquippa (net tons)		South Side No. 18 Mill (net tons)	
	8 Hr	24 Hr	Section	8 Hr
Large angles	735	1908	1-1/6-in. Rounds	581
Small angles	552	1595	1 5/8-in. Rounds	638
Flats	636	1728	3-in. Rounds	964
Junior beams—				
6-in.	412	937	1 1/2-in. Square	889
8-in.	488	1062	1 3/4-in. Square	921
10-in.	523	.....	2-in. Square	1238
12-in.	524	1480	1-47/64-in. Hex	642
Standard channels—				
3-in.	448	1134		
4-in.	503	1324		
5-in.	496	.....		
Light weight channels—				
10-in. x 8.4 lb	394	994		
10-in. x 6.5 lb	358	.....		
12-in. x 10.6 lb	381	839		
Rim section—				
5-in.	434	1107		
6-in.	565	1209		
7-in.	593	1249		

A close analysis of the above figures would indicate

that from a production standpoint, the semi-continuous cross-country mill would have it all over the straight-away continuous mill. However, when we consider the difference in commodities and foot-weights, and the lack of sufficient accessory equipment on the straight-away continuous 14 in. mill, it still becomes a debatable question.

DISCUSSION

PRESENTED BY

C. W. BARRETT, Chairman Rolling Mill Committee, Republic Steel Corp., Cleveland, Ohio

L. C. SOWELL, Superintendent Blooming and Rolling Mills, Jones & Laughlin Steel Corp., Aliquippa, Pa.

GEORGE PIMLOTT, Roll Designer, Republic Steel Corp., Cleveland, Ohio

WILLIAM WALLACE, Roll Designer, Rotary Electric Steel Co., Detroit, Mich.

C. W. Barrett: What type of straightening equipment do you use between the cooling bed and shears on cut-to-length bar products?

L. C. Sowell: There are two straighteners which when needed are set in at the discharge end of the cooling bed. These straighteners are revamped machines. The rolls are overhung and are mounted on tapered anti-friction bearings. Adjustments are made by hand. Each machine is driven by an individual variable speed motor, and has a maximum delivery speed of approximately 1300 feet per minute.

George Pimlott: You said 3200 fpm was the delivery speed of your mill. Do you straighten anything off the mill at that 3200 fpm delivery speed and, if not, how do you keep ahead of the mill? In other words, to sell straightened products, can you keep up with the mill, or is it a bottleneck?

L. C. Sowell: We do not straighten the product directly off the mill (roll train). The speaker merely stated that there was an available delivery speed of 3200 fpm from the finishing stand. However, we have never utilized the maximum having only attained up to 2400 fpm.

From the mill the bar is delivered into a hot runout table and thence to the cooling bed; from thence to what we term the cold runout table and into the straighteners at the discharge end of the bed.

These machines deliver the bar at a maximum of 1300 fpm, and can handle 75 tons per hour. They are capable of accommodating the present heating capacity but will not handle the rolling capacity.

George Pimlott: To keep ahead of the mill and straighten, you have to take a bar off the hot bed for every one that is put on by the mill. Can this be done? I am very much interested in the kind of straightening equipment you have.

L. C. Sowell: In a way your statement may be termed correct. However, with our present equipment, the mill is able to utilize the cooling bed as a reservoir. On the discharge end of the cooling bed we have a series of sliding dogs which is termed the gathering device. One or more of the bars may be lifted by means of these dogs midway of its travel across the cooling bed and pulled over onto the cold runout rolls, and as explained in the previous question, they are then entered individually into each of the straightening machines.

William Wallace: Do you experience more variation throughout the bar on the straight-away mill than on the cross-country type?

L. C. Sowell: Yes, we do. The straight-away mill is more subject to a pull because you might have the bar in seven or eight stands at the same time, if it is a light section. If it is a heavy section, it might be in only two or three stands. Variations in temperature, grade of steel and length of bar may aggravate this condition.

However, with the equipment available, an experienced mill operator can easily control these features by means of an almost instantaneous roll speed adjustment, lever-operated.

I did not make too much mention of maintenance in my paper but the problem of maintenance is always with us. We are continually making changes for the better in order to reduce delays and operating costs. If we run into too much difficulty at any particular point, then we do our best to make the proper changes to correct the undesirable situation.

One of our problems at the moment is the mill hot runout table which is being progressively rebuilt. The rebuilding is accomplished during ordinary shutdown periods without the loss of any regular scheduled operating time.

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GROUNDING PRACTICE AT INLAND STEEL

. . . . proper grounding design and detail will eliminate troubles from lightning . . . . care must be taken to prevent galvanic currents and subsequent corrosion of plant piping . . . .

By V. E. SCHLOSSBERG
Assistant Chief Engineer
Inland Steel Co.
East Chicago, Ind.

▲ IN the National Electric Code, under Article 250, it is stated, "Circuits are grounded for the purpose of limiting the voltage upon the circuit which might otherwise occur through exposure to lightning or other voltage higher than that which the circuit is designed; or to limit the maximum potential to ground due to normal voltage."

About thirty years ago the Inland Steel power system consisted of a generating capacity of approximately 25,000 kw with its associated load at 2300-v, 3-phase, 25-cycle. The system was practically trouble free from lightning disturbances. Inland then electrified the Plant No. 1 mills and the generating system was increased to approximately 50,000 kw with its associated load. It looked to us like lightning said here's a place big enough for our attention because at the ends of the lines, lightning began paying us visits. Inland went to lightning arrestors at the base of each motor and our lightning troubles disappeared. You will recall in those days, station lightning protection was furnished by the electrolytic arrestor which was charged once every eight hours. Choke coils were the device of the day.

Inland then had an expansion of the merchant mills involving additional 2300-v feeders and where these feeders crossed over the top of the open hearth, lightning would strike. Arrestors were installed at this point and feeders shielded from the hot gases where they passed through the monitor of the roof. This eliminated the lightning trouble.

Inland then installed the first units of the hot strip mills. Power was transmitted to the location, approximately one mile away, by two 1,000,000 circular mil, 6600-v feeders. The 6600 volts was new to us and we inquired throughout the trade about the lightning arrestors at the base of each motor. However, no one could give us encouragement so we made the installation along the known conventional lines with the station arrestors at the bus and line type arrestors out at the line the correct number of feet from the station. Lightning again decided to notice us and first visited one of the transformer banks and motors at this location. Although we could still arouse no enthusiasm among the trade, we decided to go along with our 2300-volt practice and install 6600-volt arrestors at the base of each motor. Since this installation motors and transformers have been trouble free from lightning.

Later the trade began recommending the installation of capacitors as well as lightning arrestors at the base of each motor and we installed the capacitors. However, lightning would still come down and visit the feeders which by this time had grown to six 1,000,000 circular mil circuits or a total of eighteen 1,000,000 circular mil cables. Ground wires were first beginning to be recognized as being effective, and we installed over this circuit a single 1/0 ground wire grounding it at each end of the line and in the middle. It was not effective so we decided to ground it at each tower which were on 200 ft spans. We sank grounds and measured them until we had a ground resistance of less than two ohms. This has appeared to date to have stopped lightning strokes. Also, we have recently increased these circuits to eight, and in so doing have installed two ground wires over the feeders. To us this spells out that if one wants overhead conductors free from lightning strokes and motors and transformers free from lightning damage, one should install overhead ground wires properly grounded at each tower with lightning arrestors and surge capacitors at each motor location.

INITIAL GROUND

Whenever we break ground for a new power house, substation or motor room, we determine where we have the nearest large water main. We then connect to this water main a 1,000,000 circular mil bare, copper cable and run this through the ground for such a length that the cable is a ground within itself without the water main, and then to the basement of the motor room or substation from where you may see the 1,000,000 circular mil copper cable running around the basement of the motor room or you may see $\frac{1}{4} \times 4$ in. copper bus. Our people check the resistance to ground of this circuit and we are always sure to have it less than two ohms without the connection to the water lines. This is the heart of the system and it makes no difference how many wire ground connections you put on if you do not have a good ground, the units are not grounded. If there is a building and there are no water lines fastened to the building, we will connect the building at several points to our ground conductor.

GROUNDING

Marked ground transformer leads, marked potential transformer leads are grounded to this ground con-

ductor. Corona shields are connected to this ground conductor and care is taken to see that a conductor of the proper size is used for making the ground connection. For this data, refer to the National Electric Code on size of conductors to be used for grounding. Motor-generator set bed plates, motor bed plates and in many cases the uninsulated pedestals and frames are separately grounded. In addition, outside of switch boxes, rheostat frames, metal clad switchboards are all separately grounded. In fact, our motto is, "When in doubt, install additional ground wires."

Most of this grounding is done with bare conductor of flat braid. Occasionally the question will be asked, should the lightning arrestors be fastened to the same ground or should there be a separate ground for the lightning arrestors? Our practice is to connect the lightning arrestors to the same ground, but we always make certain that this is the point nearest to the ground connection.

Frames of transformer banks are connected to ground, in fact, every piece of metal equipment housing electrical equipment within the power house, motor room or substation is grounded.

AUXILIARY EQUIPMENT

The auxiliary equipment in our plant is divided into many voltages. I will start with 440 v, 3 phase, 25 cycle. Every motor, pushbutton, control cabinet or any metal containing electrical parts is connected to ground as thoroughly as we handle the units in the power houses, substations, and motor rooms. These ground connectors are visible from the outside of the equipment, and where vibration exists flexible wire is used. While we are on 440 v, 440 v is never used for control, but each 440 v unit has its own control transformer and 110 v is used for the control circuit. In some cases, large a-c contactors, too large to be handled by 110 v, has been handled by 220 and 440. However, that circuit does not leave the control board and our present practice is to meet that condition with d-c. We operate our 440-v systems insulated from each other and at the present time we have seventeen systems.

The 250-v d-c is generally not grounded. We rely upon the normal metallic equipment supports to provide the ground. However, we are discussing this policy within our organization at the present time. An item of interest on our 250 v d-c system is that initially we operated the 250 v d-c system as a single system within the plant with all ties closed, but our experience is that we obtain greater motor life with the operating systems insulated and at the present time we are operating eight separate 250-v d-c systems. Ties are provided so, in case of emergency, one system can be tied to another. As the systems are ungrounded, each system must be checked for ground before being tied together. We have ground detectors operating on the 250-v d-c, 440-v, 2200-v and 6600-v a-c systems. Grounds are never tolerated on 6600-v, 2200-v or 440-v systems.

The days of grounds on the 250-v system appear to be diminishing. That is, you rarely see lights flashing as one would see 20 years ago. However, this has been brought about largely by improving maintenance rather than a determined effort on our part to locate the ground on the 250-v system and remove it.

LIGHTING

Our lighting power is 220 v, a-c or d-c. All transformers, switches and metal parts housing electrical connections are grounded in the same manner as the 440-v units. Our present policy on office lighting is 208/110 volts. In large offices, we divide the circuits so lights are connected to all three phases to eliminate the 25-cycle flicker. This is, of course, 208/110 with the grounded neutral. Panel boards are properly connected to ground.

OFFICE EQUIPMENT

This brings us quickly to office machinery. We are endeavoring to make all office machinery either 110 v, 25 cycle, or where impossible, 110 v, 60 cycle, furnishing converting units for the 60 cycle. We use conventional duplex plugs and do not ground the piece of office machinery unless it would be located close to a radiator or other substantial ground. This is grounded to protect the person in case they should reach out and touch the radiator.

We still have some 250-v d-c office equipment. In this case the equipment is grounded through a 3-wire polarized plug.

PORTABLE EQUIPMENT

We are endeavoring to make portable equipment used in the field 110 v, 25 cycle and where it is used as such, the equipment is not grounded unless being used in a hazardous location. We still have some 250-v d-c portable equipment and all such equipment has a ground wire connected to it.

On portable 440-v equipment such as man cooling fans, we use a three-conductor cable protected by a ground basket and ground wires imbedded in the conductor. This cable has the normal three rubber covered conductors and one ground conductor surrounded by a mesh of copper which completely encloses the conductors. The mesh and the ground wire are grounded at the switch to a terminal provided for it, and are also connected to the metal part of the man cooling fan.

HAZARDOUS LOCATIONS

In our benzol plant we have 32 main grounds each driven to a depth of 20 ft which is below the water table. All pipe lines with flanges are bonded at each flange. All electrical equipment is of the explosion proof type and all switches, pushbuttons, starters, motors, fixtures, conduit and metal coverings of insulation on pipe lines are grounded. Insulated bonds are provided at the railroad tracks entering the benzol plant approximately 30 ft from the gate and all tracks inside the benzol plant are grounded and bonded. Static proof belts are used. No switches of any kind are used inside the benzol building as all switches are weatherproof and mounted on the wall outside of the building. Wire is not used to tie insulation around pipes carrying

liquor. Tanks are not painted with aluminum paint but are painted with static proof paint. All chain valves, chain falls and hoists are equipped with static proof chains. Static proof tools are used. Men are furnished with explosion proof flashlights and we recommend the use of rubber shoes for people working in highly explosive places.

For people using lights in hazardous locations we provide small portable lighting transformers, each one large enough to handle 5-50 watt lamps. The voltage for the lights provided is 12 volts. The lights are equipped with left hand threads so they cannot be screwed into high voltage receptacles and we provide a special receptacle at the transformer end and a special plug on the extension so it cannot be inserted into an outlet of the wrong voltage.

STATIC ELECTRICITY

The problem of static electricity is watched constantly in our plant, for example when using a varnish gun, the gun is always connected to ground with a ground wire.

In closing I would like to suggest that you make reference to the National Electric Code as it contains a very good article on grounding as well as data on other important subjects. I feel sure that if you will use it as a guide, your company, your men and you will all gain.

DISCUSSION

PRESENTED BY

J. D. MARINO, Supervisor of Design, United States Steel Co., Duquesne, Pa.

V. E. SCHLOSSBERG, Assistant Chief Engineer, Inland Steel Co., East Chicago, Ind.

D. L. BEEMAN, Manager, Industrial Power Division, Industrial Engineering Divisions, General Electric Co., Schenectady, N. Y.

H. H. ANGEL, Engineering & Construction Department, Bethlehem Steel Co., Bethlehem, Pa.

W. E. COLEMAN, Research Laboratory, United States Steel Co., Pittsburgh, Pa.

J. D. Marino: Our grounding practices in general are very similar to those described by Mr. Schlossberg. In regards to overhead line protection, we have had better results on our high lines from placing the ground wires ten to eleven feet above the top phase wire than we have had by using five to six feet. I wonder if Mr. Schlossberg has had similar results and would care to comment on this detail?

I have just one other question. Have you had any indications as to whether or not using water mains for grounding purposes will accelerate corrosion of the pipe, especially if there is some d-c ground current?

V. E. Schlossberg: We set the height by establishing an angle from the ground wire. As long as your spread does not cover more than forty-five degrees the ground wire should be effective.

On the corrosion of the water mains, we would like to report that to date we have had no trouble with the corrosion of water mains in our plant back to 1926. We believe this is partially due to the system of grounding. We establish an earth ground of less than two ohms before we attach to the water mains. One of the other speakers said they establish a ground of less than two-tenths of an ohm. That is good. The lower you can get the better. The National Electric Code provides for twenty-five. So we are doing twelve times better than the code requires. The other gentleman, I believe, is doing one hundred and twenty times better than the Electric Code.

D. L. Beeman: Mr. Schlossberg has covered the subject of grounding so well that there is little if any to add. The problem of grounding is essentially the same in all industrial plants large and small. Unfortunately a great many plant operators do not engineer their grounding system as Mr. Schlossberg has. As a result the grounding practice varies from the high quality job described by the author to hit and miss grounding or no grounding at all. There have been serious accidents and fatalities due to poor grounding.

To further substantiate Mr. Schlossberg's viewpoint I would like to point out that our plant practice closely parallels that followed at Inland Steel. First of all we ground the neutral of systems regardless of voltage. This reduces shock hazards on low voltage systems, improves service reliability and reduces maintenance.

For earthing, as it is sometimes called to distinguish from system neutral grounding, we provide a ground mat of at least 250 MCM conductors. Ground rods are driven at each corner of the building and at each major substation or switching or machine room location. The ground rods all interconnect through the ground mat and in turn the ground mat is connected to water pipes. Each section of the steel frame of the building is grounded at several points by connection to the ground mat.

All major apparatus, such as switchgear, transformer and large motor and large machine tools are grounded by a suitable conductor connecting directly to the ground mat.

We are now earthing or grounding the frames of all portable hand tools. To do this we use a new receptacle plug with a third prong on the plug for safety grounding. The safety ground wire is kept separate from the grounded current carrying conductor in all cases.

This problem of earthing or grounding is receiving more and more consideration by plant engineers. Papers of this type are very helpful in bringing the area of power system engineering from the "black art" to the finished engineering stage.

H. H. Angel: Mr. Schlossberg has presented a very interesting and instructive paper and has enumerated some instances of "growing pains" which led to the present high voltage protective system. His department made one of the earliest applications of lightning arrestor protection at the base of motors.

Mr. Schlossberg has stressed the importance of good initial grounding, the use of two ground wires for transmission systems, and keeping individual tower resistances less than 2 ohms. This practice is better than the recommended one that the average system has less than 5 ohms.

Under the item of 440-v auxiliary equipment, the grounding mentioned is carried out by practically all users, with the exception that not all ground connectors are visible from the outside. Mention is made of control voltage being 110 v. I believe that all control manufacturers should impress this fact upon all customers and especially upon those having small electrical organizations, in order to have the latter realize that certain hazards exist with 440 v control circuits, especially when mixed with 220 v a-c or 250 v d-c on panel boards, control desks, etc.

The subject of 250 v, d-c grounded and ungrounded system is a controversial one. I agree with the author that motor maintenance should be less with an ungrounded system.

On the subject of portable equipment, the Bethlehem Steel Co. grounds all equipment using 220 v, a-c, 250-v, d-c and 440 v, a-c by the use of a separate ground conductor. The use of 3-conductor cables and receptacles is gradually being increased to ground all 110-v, single phase equipment.

I would like to ask the author if any of the 440-v, 2300-v and 6600-v power systems are grounded?

V. E. Schlossberg: Our plant initially had a 2200-v ungrounded system. When we expanded the plant we went to 6600 v and most of our generation today is at that voltage. As we put in capacitors for lightning protection, we found that we could have a flow of approximately fifty amp on fault from the capacitors. You who have explored the same subject realize that when the capacity current reaches fifty amp, it is self-sustaining and that in case of a fault you may have serious trouble. To solve that problem we are installing Petersen coils on our 6600-v system.

At our plant, the neutral is not presently grounded on the 25-cycle systems of 440, 2200 and 6600 v. However, in our new open hearth plant being built with a 440-v, 60-cycle system, the neutral will be grounded, as will be the next step of our expansion tentatively planned at 13.8 kv, 60 cycles.

W. E. Coleman: Mr. Schlossberg has presented an excellent paper on grounding and I believe there is only one point which I would like to discuss briefly. It has to do with Mr. Marino's question about corrosion.

Figure 1 shows a water main system, connected to the substation copper ground bus and the copper ground, which is maintained at a resistance of 2 ohms or less to ground, is also connected to the station ground bus. I assume this resistance to ground is checked by disconnecting the copper ground from the station bus. Now if this copper ground were disconnected and an ammeter used to remake the connection, I suspect you would read a rather large current due to the galvanic action between the copper and iron buried in the earth.

I think the question in Mr. Marino's mind was, that with this condition the iron is discharging current through the soil to the copper. With current in this direction we would of course expect corrosion of the iron water mains.

I felt this short explanation would clear up the question somewhat and might further point out why the use of large copper ground beds is becoming questionable. From an electrical ground and protection standpoint the copper is ideal, but from the corrosion point of view it would be much better if a ground were made of old iron rails, for example. The iron against iron would practically eliminate the galvanic cell action.

I believe this discussion clears up the point in question and I might suggest in closing that Mr. Schlossberg try checking this galvanic current when the occasion permits. Of course, this must be done carefully as stray direct currents may tend to override the galvanic current, but the grounds are fairly close together and if it could be done when the d-c load is light, a fairly reliable indication should be obtained.

V. E. Schlossberg: In reference to Mr. Coleman's comments, Inland's practice is approximately the same as that shown in his diagram, but we have not had the

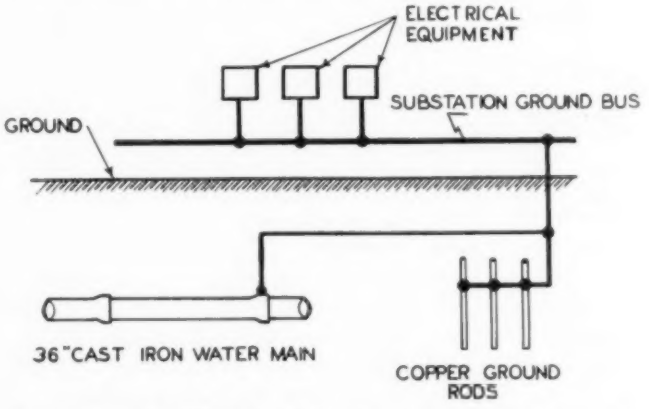
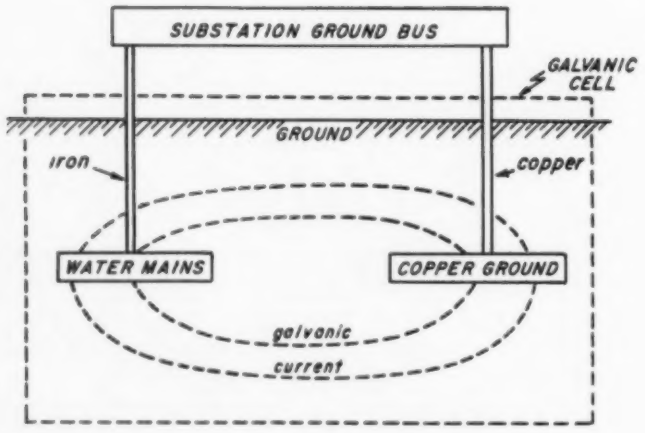


Figure 2 — At Inland Steel, a 36-in. water main is used to establish a ground bus.

Figure 1 — A short circuited galvanic cell is formed by a copper ground and iron water main ground.



corrosion mentioned by him. As Figure 2 shows our system of establishing a ground bus uses a thirty-six inch water main which runs throughout the plant. The route of this main is such that wherever we install a powerhouse, motor room or other need for electrical equipment, the location falls against this main. We do not depend on the water main for ground, but we install a group of copper ground rods in the soil in addition. With this system, a ground of less than two ohms is obtained. This is very good grounding. The results have been satisfactory. We have never been troubled with corrosion on our water mains.

Water mains installed previous to 1942 have been cast iron. Since then we have been installing wrapped steel pipe.

Storage and Distribution of Oxygen

FOR THE OPEN HEARTH

By B. P. SARASIN
and
R. TIETIG, JR.
A. J. Boynton Co.
Chicago, Ill.

. . . . the oxygen distribution system must be engineered to provide adequate storage . . . .

▲ DURING the past four years the large majority of the basic open hearth steel producers have investigated the possibility of increasing ingot production and reducing costs by the use of oxygen for flame enrichment and for decarburizing the bath. For the most part these investigations, particularly with respect to flame enrichment, have been concentrated either on a single furnace or on a small number of units in a plant and, as a rule, the oxygen used was, what is commonly termed, high purity, or 99.5 per cent oxygen. There were several reasons for these limitations, some of the more important being as follows:

1. The only oxygen available to most plants was that of 99.5 per cent purity.
2. In certain instances, the oxygen producing facilities within a single district were not large enough to supply more furnaces in the area.
3. The facilities for storing and handling oxygen within a plant were usually not adequate to meet the demands of all the furnaces.
4. The managements of the several steel producers did not deem it advisable to make the large expenditures necessary for oxygen production, storage and distribution facilities until the benefits from its use could be closely estimated from experimental data.
5. In many instances the requirements for oxygen, which would form the basis for sizing and designing a production unit and a storage and distribution system, could not be accurately determined without preliminary studies.

The results of these four years of investigations have shown that there are wide variations between open hearth plants regarding the use of oxygen. In several instances the requirements will not warrant the installation of producing facilities within the steel works; however, there are others where an oxygen plant is readily justified. In these latter instances, because of the fact that oxygen is produced at a relatively constant rate whereas its consumption is highly variable, a correctly designed storage and distribution system for the gas is necessary. It is the intent of this statement to discuss the principal features of a design of such a system which will result in the minimum operating cost including fixed charges. To do this it is necessary to consider the following aspects of the problem:

1. Preliminary design data.
2. Demand for oxygen.
3. Method of producing oxygen.
4. Storage.
5. Compression units.
6. Piping.
7. Instrumentation and controls.
8. Safety.
9. Other uses for oxygen.

The balance of this paper consists of a discussion of each of these items as applied to a particular plant where it has been demonstrated that the installation of an oxygen generating unit can be justified by increased ingot production and lower cost. In this discussion appropriate attention is given to certain economic phases.

PRELIMINARY DESIGN DATA

An example of the preliminary data necessary to correctly design a storage and distribution system is shown in the following Table I. These data are based on actual practices as compiled by P. W. Nutting and reported at the 1950 Open Hearth Conference of the American Institute of Mining and Metallurgical Engineers. The data represent typical information that must be obtained.

The source of this type of data should be actual experimental work carried out on the furnaces to be supplied with oxygen. Where there are considerable differences in the size and design of the furnaces in a plant, it is necessary to collect separate data for each size and

TABLE I

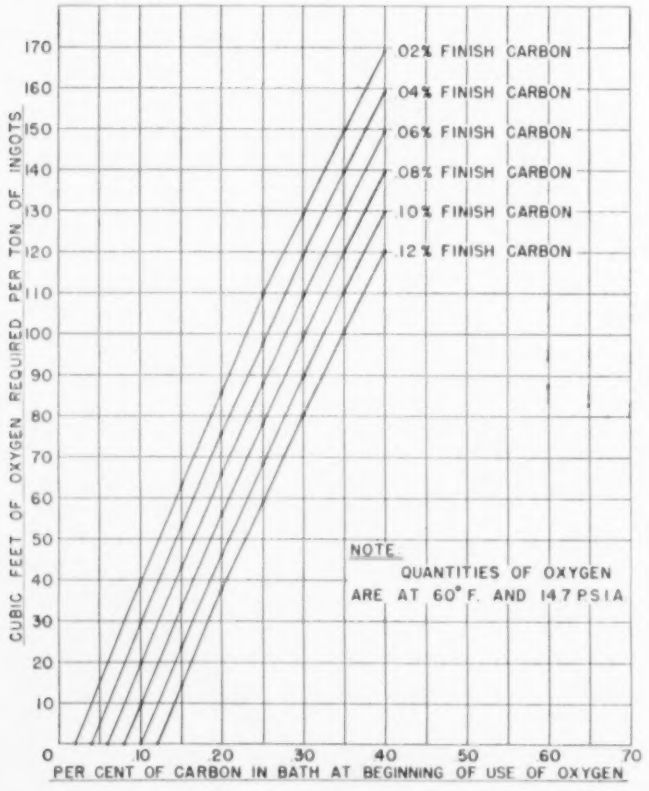
PRELIMINARY DESIGN DATA

Number of furnaces in plant	12
Weight of heats — tons	180
Average time of heats, tap-to-tap — hr	10.50
Oxygen for flame enrichment — cu ft per ton of ingots	540
Minimum oxygen pressure at burner — psig	40
Average time oxygen used for flame enrichment — hr	4.50
Oxygen for decarburizing bath — cu ft per ton of ingots	104
Minimum oxygen pressure at lance — psig	100
Average time oxygen used for decarburizing bath — hr	0.58

design. Also it should be noted that oxygen for decarburizing may not be used on certain types of heats. Such heats should not be considered in sizing a plant unless they form a considerable part of the ingot production.

While the design data shown in Table I should be based on actual practice, the quantities of oxygen for both flame enrichment and decarburizing can be approximated by other methods. The quantity for flame enrichment can be determined by estimating the difference between the maximum rate of fuel input, as limited by the amount of air that can be adequately preheated by existing regenerators, and the maximum amount of fuel it is desirable to burn. This difference or increase in fuel input must be burned by adding oxygen to the burner, and the amount of oxygen necessary is readily calculated once the amount of fuel increase has been determined. The amount of oxygen for decarburizing can be estimated from Figure 1 showing several consumption curves. These curves were determined empirically from various operating data.

Figure 1 — Chart gives amount of oxygen required to decarburize steel.

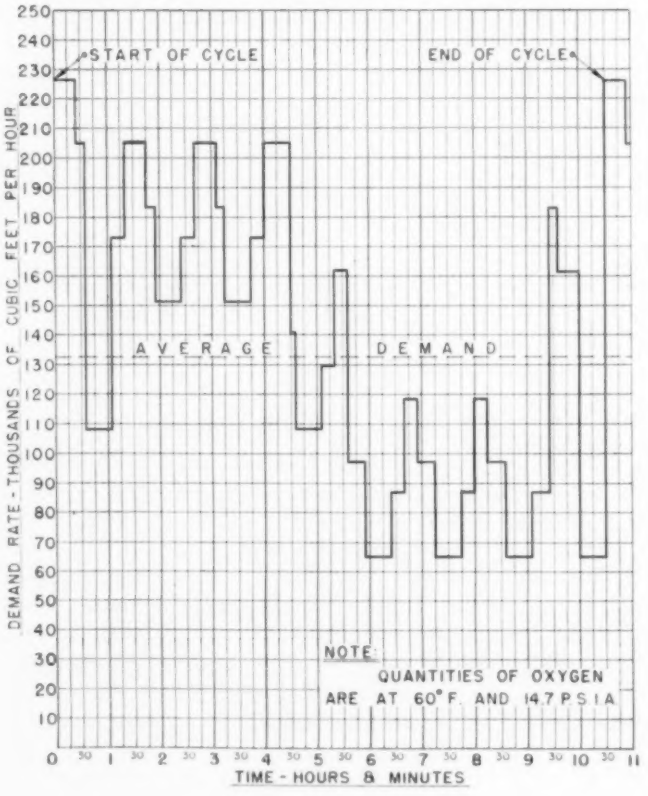

.02% FINISH CARBON
.04% FINISH CARBON
.06% FINISH CARBON
.08% FINISH CARBON
.10% FINISH CARBON
.12% FINISH CARBON
NOTE
QUANTITIES OF OXYGEN ARE AT 60° F. AND 14.7 P.S.I.A.
CUBIC FEET OF OXYGEN REQUIRED PER TON OF INGOTS
PER CENT OF CARBON IN BATH AT BEGINNING OF USE OF OXYGEN

DEMAND FOR OXYGEN

The preliminary data having been obtained, the next stage in the design of a storage and distribution system is to use these data to determine the demand for oxygen. This can be most readily done by the preparation of a demand chart. Such a chart is shown on Figure 2. This chart which is based on data in Table I, shows a condition of so-called "bunched heats" where the temporary demand for oxygen is far in excess of the rate of generation. The degree to which the heats can be bunched is largely limited by the number of ladle cranes and charging machines, and in this example it is assumed that there are three cranes and three charging machines in the 12-furnace plant. Since oxygen for flame enrichment is usually used only during and immediately after charging, the three charging machines will limit the number of furnaces using oxygen in the burner at the same time. Oxygen for decarburizing is principally used immediately prior to tapping, hence the three ladle cranes will usually limit to three the number of furnaces requiring lance oxygen at the same time.

Figure 2 was prepared by plotting the oxygen demand by the individual furnaces over a period of 10 hours and 30 minutes, which as indicated by Table I, is the time of a complete cycle. These individual furnace demand charts were then grouped as if three furnaces were tapping and three furnaces were charging at the same time, and the remaining six furnaces were charging at equally spaced intervals over the remaining period. After grouping, the total demand at any time for all 12 furnaces was readily calculated and the result is shown by the chart.

Figure 2 — Chart shows oxygen demand required for a 12-furnace open hearth plant, based on data in Table I.


START OF CYCLE
END OF CYCLE
AVERAGE DEMAND
NOTE
QUANTITIES OF OXYGEN ARE AT 60° F. AND 14.7 P.S.I.A.
DEMAND RATE - THOUSANDS OF CUBIC FEET PER HOUR
TIME - HOURS & MINUTES

Also shown in this Figure 2 is the average demand for oxygen. This was calculated from the data in Table I and is 132,500 cu ft or approximately 5.52 tons per hour. This determines the minimum size of the oxygen generating unit.

The relation between the actual demand and the average demand shows that there are several periods during a cycle when the requirements for oxygen exceed its rate of production. This means that storage facilities must be provided if an adequate supply is to be maintained to meet all demand conditions. For the conditions shown on the chart, which represent severely bunched furnaces, storage for at least 202,000 cu ft or approximately 8.42 tons should be available. Assuming facilities of that capacity are available, Figure 3 shows the quantity of oxygen in storage at any time for a complete cycle having furnace charging and tapping intervals as set forth for Figure 2.

The preparation of the demand chart is the most important preliminary step in design of an oxygen storage and distribution system. It is this chart that determines the size of the oxygen generating plant, storage facilities and piping. The experimental data on which it is based should be carefully assembled and the operating conditions, particularly with reference to "bunched heats," should be a true appraisal of what may occur at reasonably frequent intervals. Extreme conditions may be neglected since a momentary lack of supply of oxygen is not serious.

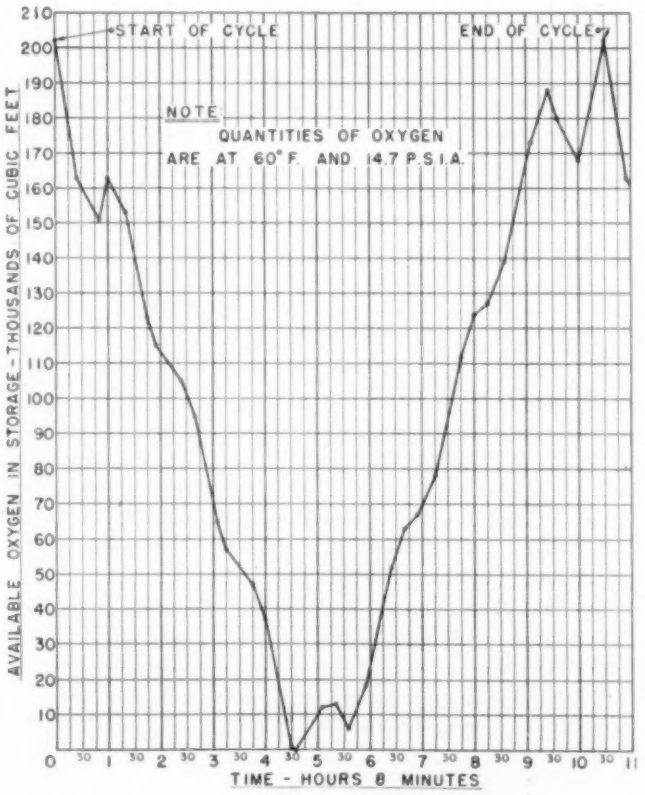
METHOD OF PRODUCING OXYGEN

Having determined the capacity of the oxygen generating plant the next step in the design of the storage and distribution system is the selection of the oxygen producing unit. With respect to this, it should be noted that oxygen of somewhat less purity than the 99.5 per cent, generally available, is entirely satisfactory for both flame enrichment and decarburizing. Since oxygen of approximately 95.0 per cent purity can be produced at a cost substantially less than that of the 99.5 per cent grade, the generating unit should not be required to produce the higher purity gas except possibly as a by-product in small quantities.

There are several designs available for these generating units, all producing oxygen of 95 per cent purity at competitive costs. These various designs all employ the same basic principle of liquefaction and rectification of air. The cycles employed vary considerably but the initial plant cost, consumption of power and other utilities and the space requirements are closely comparative. Selection of the generating unit will accordingly be governed by technical preferences, and the estimated installation cost.

While it has no bearing on the selection of the generating plant, there is one feature of any generating unit which affects the design of the storage and distribution system. This feature is that the rate of oxygen production cannot be readily adjusted to meet short period demand variations. For this reason the rate of production should be considered as a constant for periods of not less than eight hours and any major adjustment in the production rate should be based on the projected demand for oxygen in the succeeding eight hour period.

Figure 3 — Chart shows oxygen in storage which is available for use.


START OF CYCLE
END OF CYCLE
NOTE
QUANTITIES OF OXYGEN
ARE AT 60° F. AND 14.7 P.S.I.A.
AVAILABLE OXYGEN IN STORAGE - THOUSANDS OF CUBIC FEET
TIME - HOURS & MINUTES

STORAGE

Since the production rate of oxygen can be considered as a constant and since, as shown by Figure 2, this rate is frequently exceeded by the demand, the need for storage facilities for the gas is obvious. The extent of these facilities and also the pressure at which the gas should be stored are dependent on local conditions. For example, an open hearth plant of 12 furnaces will have a more constant demand rate for oxygen than a plant of four furnaces. Consequently the storage facilities of the latter, expressed as a percentage of oxygen producing capacity, will be much greater. In a second case it can be shown that where the demand for decarburizing oxygen is much greater than that for flame enrichment, storage will likely be at a higher pressure than if the reverse were true. Also it should be noted that in certain instances the design may be influenced by state regulations or codes that are more rigid than the standards of the American Society of Mechanical Engineers. In any event, the design of storage facilities for an open hearth plant is a problem requiring individual study for a particular condition.

There are three general types of storage facilities that might be considered. These are the constant pressure, variable volume gas holder; the spherical type of pressure vessel, either in single or multiple units; and the cylindrical pressure vessel, also in one or more units. Typical applications of each of these types of storage facilities are shown in the following Figures 4, 5 and 6. The capacities, pressures and demands as illustrated by these figures, are based on the data in Table I and the demand chart of Figure 2.

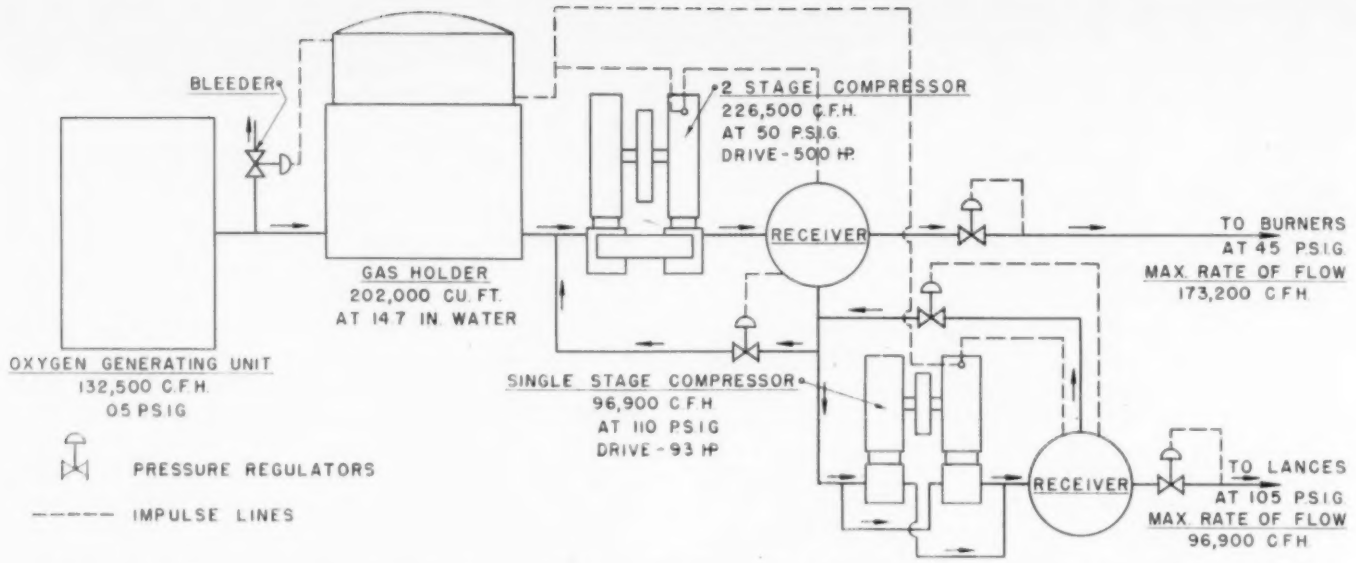


Figure 4 — Storage and distribution system illustrated uses variable volume constant pressure gas holder. Quantities of oxygen are at 60 F and 14.7 psia.

Figure 4 shows an installation where storage is provided by a gas holder. The principal items to note regarding this system are as follows:

1. The storage pressure can vary up to a limit of 14.7 inches of water. This limiting pressure, which is only slightly above atmospheric, is the maximum possible in any standard holder developed up to this time.
2. The primary or 50 psig compressor is sized to meet the maximum demand rate for oxygen which is much greater than the rate of generation. Consequently the initial cost of this compressor and the horsepower of the drive are considerably greater than for a system using spherical pressure vessels, where the capacity of the compressor is equal to the maximum output of the oxygen generator.
3. The capacity of the primary compressor being much greater than the capacity of the generating unit, it necessarily follows that the compressor will be operating frequently in a range of lower efficiency.
4. The booster compressor is only required to have a capacity equal to the maximum demand rate for decarburizing oxygen whereas with storage in spherical pressure vessels, its capacity should equal that of the generator.
5. Only one storage unit is required. If two or more units were installed, the cost per cubic foot of storage capacity would be higher than with the single unit.

Figure 5 shows a system where spherical pressure vessels are used for oxygen storage. This shape of vessel is recommended for storage of gaseous oxygen under moderate pressures up to 150 psi gage because of its low initial cost. Where the maximum storage pressure exceeds 150 psig, storage can generally be provided more economically in cylindrical vessels. Features to be noted in the system illustrated by Figure 5 are as follows:

1. The capacity of the primary or 50 psig compressor is only equal to the maximum output of the oxygen generator. Hence this compressor will usually be operating in a range of higher efficiency than the primary compressor used with a gas holder, which, as previously stated, must have a capacity equal to the maximum demand for oxygen. Also the horsepower of the drive is only about 59 per cent of that required with the gas holder.
2. The capacity of the booster compressor must also equal the maximum output of the generator. This is in contrast with the system using the gas holder for storage, where the capacity of the booster compressor need only equal the maximum demand of oxygen for decarburizing the bath.
3. Two spherical storage tanks are provided. This requirement for two vessels results from the limitations imposed by the ASME Code for Unfired Pressure Vessels with respect to diameter of tank, thickness of plate, and maximum storage pressure. This code limits the thickness of plate that may be used for the construction of fusion welded pressure vessels, without stress relieving, to 1¼ inches. Using a 1¼ inch plate made of 55,000 psi minimum tensile strength steel and allowing 1/16 in. for corrosion, the largest diameter of spherical vessel that could be constructed for a maximum working pressure of 110 psig and still fall within the ASME code, is approximately 39 ft 6 in. This is considerably less than the 45 ft 5 in. diam of vessel indicated by the demand chart of Figure 2 as being necessary. Hence, two vessels must be used. By using plates heavier than 1¼ in., adequate storage could be provided in a single vessel. However, the difficulties of stress relieving on site, a sphere 35 or more ft in diam will probably eliminate that possibility.

An oxygen storage and distribution system using several cylindrical pressure vessels for storage, is shown by Figure 6. Vessels of this shape are generally recommended when the maximum storage pressure is to exceed 150 psig. Noteworthy features of this system are as follows:

1. Only one compressor having a capacity equal to

the output of the generator is needed. Due to the specified delivery pressure of 250 psig, the unit should have three compression stages. Also because of the delivery pressure, the horsepower of the drive is about 40 per cent greater than that required for the combined drives of the primary and booster compressors used with the spherical storage vessels. The horsepower of the combined drives used with the gas holder is about equal to that required with this system.

2. Storage facilities consist of six cylindrical pressure vessels each having a diameter of 10 ft 3 in., and an overall length of 43 ft 8 in. The size of the individual vessels is limited by the ASME Code and problems of transportation of the vessels from manufacturer to site. The ASME Code states that the plate thickness shall not exceed 1¼ inches without stress relieving and railroad facilities can not transport a cylinder having a diameter greater than 10½ feet.

The spare compressor equipment that should be installed is one of the important factors in determining which one of the three storage systems should be adopted. Table II outlines the comparison of the necessary spare compressors in each of the systems. In preparing this table it has been assumed that reciprocating compressors will be used in all instances. The possibility of using centrifugal units is discussed in the next section of this statement.

It is of particular interest to note in this comparison that no spare booster compressor is required with the spherical pressure vessels. The reason for this is discussed in a subsequent section and results from an arrangement of piping whereby the second stage or high pressure cylinder of the spare primary compressor can act as a spare for the booster compressor. This is not feasible with the gas holder because of the large difference in capacities between the primary and booster units.

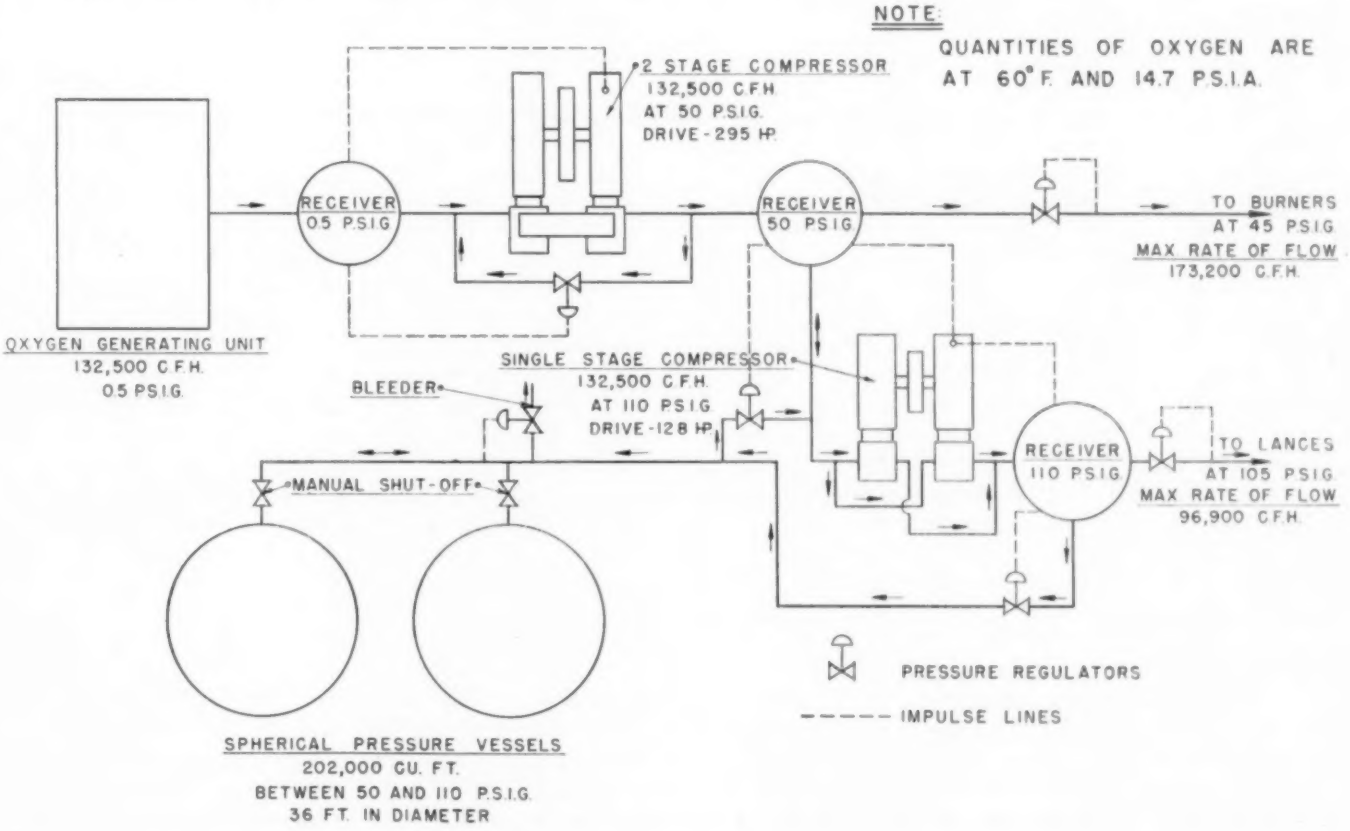
Considering the application of each of the three types of storage systems to the data in Table I and the demand chart of Figure 2, it can readily be seen that the

TABLE II

COMPARISON OF REQUIRED SPARE COMPRESSOR EQUIPMENT

Item	Gas holder	Spherical pressure vessels	Cylindrical pressure vessels
Number of spare primary compressors	1	1	1
Capacity of spare primary compressors, cfhr	226,500	132,500	132,500
Delivery pressure spare primary compressor — psig	50	50	250
Connected hp spare primary compressor	500	295	590
Number of spare booster compressors	1	None	None
Capacity of spare booster compressors—cfhr	97,000	....	....
Delivery pressure spare booster compressor — psig	110	....	....
Connected hp spare booster compressor	93	....	....
Total connected hp all spare compressors	593	295	590

Figure 5 — This storage and distribution system uses constant volume spherical vessels.



system utilizing the spherical pressure vessels is to be preferred. This results from the following:

1. The highly variable demand would require a much larger primary compressor if a gas holder were installed instead of spherical pressure vessels.
2. The larger primary compressor required with the gas holder would usually operate in a range of lower efficiency than the recommended unit.
3. The peak demand for decarburizing or high pressure oxygen being less than the capacity of the generator and the booster compressor, it is not necessary to store oxygen at a pressure above that required for decarburizing.
4. Spherical pressure vessels designed for the required maximum storage pressure of 110 psi gage have a lower initial cost than do cylindrical vessels for the same pressure.

While the foregoing statements show a preference for storage in spherical pressure vessels, other conditions of demand and use may result in the selection of one of the other two types of storage vessels. With a relatively constant demand for oxygen, such as may be found in a large steel works where several open hearth plants are supplied from one generator, the gas holder may provide the most economical installation. In another instance, where the maximum demand for decarburizing oxygen exceeds the rate of production of the generator, storage in cylinders is preferable to that in either the gas holder or spherical pressure vessels.

COMPRESSION UNITS

All three storage systems illustrated by Figures 4, 5 and 6, require primary compressors and in addition the first two require booster compressors. Here again the selection of the correct units largely depends on local conditions. There are two types of compressors that may be considered. These are the reciprocating or positive displacement type and the centrifugal compressor. The principal features of each of these types that recommend its selection are as follows:

1. Reciprocating compressors can be furnished in standard units for any capacity up to approximately 300,000 cfhr or more and with delivery pressures far beyond 250 psig. In comparison, centrifugal compressors having delivery pressures of 50 psig and higher are not standard except for units having very large capacities. For example, centrifugal machines having a delivery pressure in the 50 psig range and having capacities of less than 300,000 cfhr are found only in isolated cases and those in the 100 psig pressure range are seldom smaller than 600,000 cfhr.
2. By using relatively simple controls, the stable operating range of a reciprocating compressor is from zero to 100 per cent of capacity. In contrast with this, the stable operating range of a centrifugal compressor having a capacity of 300,000 cfhr at 50 psig is from 50 to 100 per cent of capacity and the range of a 600,000 cfhr, 100 psig unit is about 70 to 100 per cent. It should be noted, however, that the stable operating range of the centrifugal machines can be increased by including special design features which in turn will increase the initial cost.
3. The initial cost of one 300,000 cfhr, 50 psig reciprocating compressor is about $15,000 less than that of a centrifugal unit of the same capacity and delivery pressure. However, two 300,000 cfhr, 110 psig reciprocating machines will have an initial cost about equal to one 600,000 cfhr, 110 psig centrifugal compressor.
4. The steam requirements of comparative reciprocating and centrifugal compressors are shown in Table III.

Figure 6 — Storage and distribution system shown uses constant volume cylindrical pressure vessels.

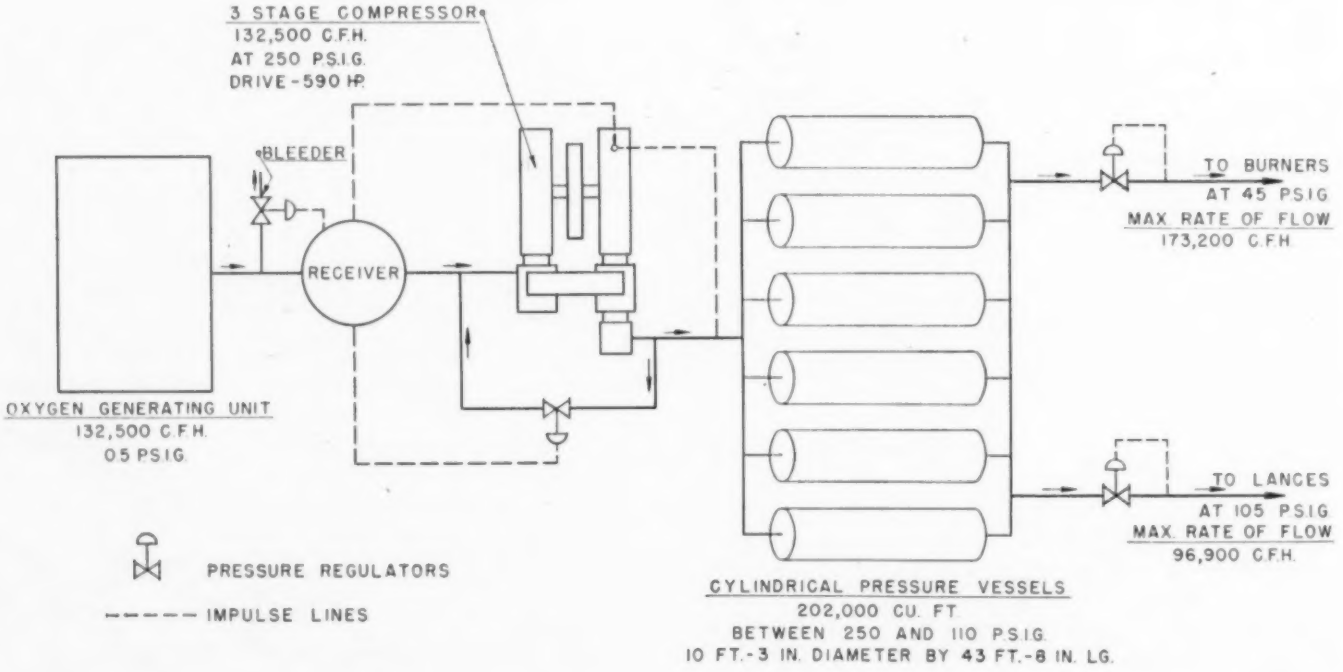


TABLE III

COMPARISON OF STEAM REQUIREMENTS

FOR OXYGEN COMPRESSORS

Item	300,000 cfhr 50 psig Compressors		600,000 cfhr 110 psig Compressors	
	Reciprocating	Centrifugal	Reciprocating	Centrifugal
Inlet steam pressure—psig	250	250	250	250
Inlet steam temperature—F	600	600	600	600
Exhaust vacuum—in. Hg	26	28	26	28
Steam consumption, 100 per cent load—lb per hr	9,320	8,550	23,600	21,300
Steam consumption, 75 per cent load—lb per hr	7,150	6,580	18,100	16,300

While this table assumes a steam drive for either the reciprocating or centrifugal units, local conditions may warrant the adoption of an electrical drive. If that is the case, the kw consumptions of the reciprocating unit will be somewhat less than that of the centrifugal machine for the same conditions of air delivery.

5. By the correct selection of both primary and booster reciprocating compressors, the second stage of a two stage compressor, duplicating the primary unit, can serve as a spare for the booster unit. In this manner a single compressor can serve as a spare for both primary and booster machines. With centrifugal compressors, separate spares are required for the primary and booster units. The elimination of a separate spare for the reciprocating booster compressor in a 132-ton oxygen plant is estimated to amount to approximately $35,000. This estimate includes not only the compressor itself but also the piping, controls, building area and installation costs.

It should be noted in the preceding paragraphs one through five, that the various comparative data applies only to compressors having far greater capacities than those required by the installation used as an example in this statement. This results from the fact that up to the present time, the application of comparatively small centrifugal units for the compression of oxygen to pressures of 50 psig or higher have been so few that completely reliable performance data are not available. Furthermore, such small units as have been installed are of highly specialized construction with consequent high initial cost.

It can be concluded from the foregoing discussion that the compression units of an oxygen storage and distribution system for the open hearth facilities of a steel works will generally be the reciprocating rather than the centrifugal type. However in a very large steel works where the following combination of circumstances may exist, consideration can be given to installing centrifugal units:

1. Storage is provided in either spherical or cylindrical pressure vessels. If storage is provided in a gas holder, the compression units should have a wider stable operating range than is usually found in centrifugal compressors.
2. The total usage of oxygen exceeds 300,000 cfhr.
3. The demand for oxygen is sufficiently constant that the centrifugal units will operate within their limited stable operating range.

PIPING

The piping system required for the storage and distribution of oxygen for use in open hearth furnaces is not the highly specialized installation as may be first suspected. The general features of design are, with a few, well defined exceptions, similar to those required for compressed air lines. For example, either standard or extra heavy steel piping may be employed, depending on the pressures and plant standards, and the size of the pipe should be determined from the maximum flow as shown by the demand chart of Figure 2, and the allowable pressure drop. The exceptional features to which attention is called are as follows

1. Welded, screwed or flanged connections may be used. In the case of screwed connections, the lubricant should be litharge and glycerine; oil, grease or any other combustible material is not permissible.
2. Gaskets should be of pressed asbestos or some other suitable noncumbustible material. Valve packing should also be of a non-combustible material; packing employing cotton should not be used.
3. All pipe fittings, valves, and other piping accessories should be cleaned free of oil, grease and other combustible substances.
4. Oxygen piping shall be so arranged as to be free from any possible contamination by oil, grease and other combustible substances. Lines of such combustible materials should not be run directly above the oxygen lines.

INSTRUMENTATION AND CONTROLS

The instruments and controls necessary for the satisfactory operation of an oxygen storage and distribution system supplying open hearth furnaces from a generator are rather extensive. This can be readily seen from Figure 7 which shows the control center for a system where oxygen is stored in two spherical pressure vessels as exemplified by Figure 6.

This control center consists of the following major items:

1. Temperature and pressure recorders for oxygen as delivered from the generator. The metering of this oxygen is part of the controls at the generator.
2. Flow meters, flow controllers and pressure and temperature recorders for the 40 psig burner oxygen.
3. Flow meters, flow controllers and pressure and temperature recorders for the 100 psig lance oxygen.
4. Pressure recorders and controllers for both the 50 and 110 psig receivers.
5. Pressure and temperature recorders for the two spherical storage vessels and controllers for the atmospheric relief of the vessels.
6. Flow meters, and pressure and temperature re-

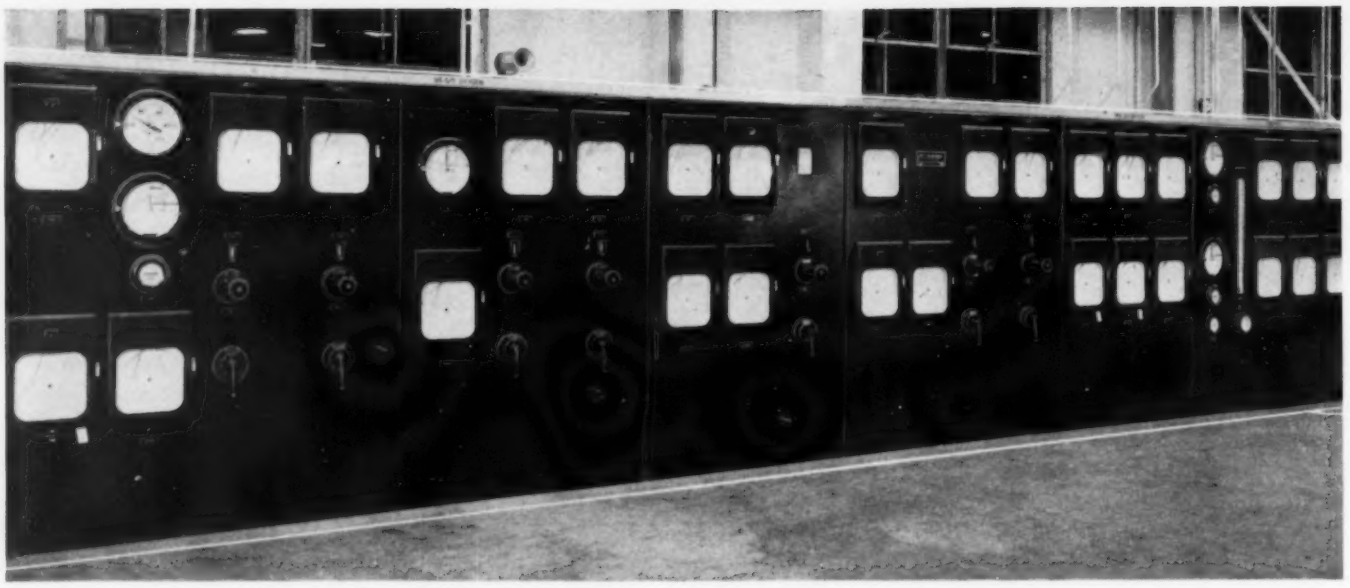


Figure 7 — Control center for oxygen storage and distribution system.

corders for the steam and water used in the distribution system.

7. Speed regulators for the compressors.

Also shown on this Figure 7 are the instruments and controls for the distribution of the 99.5 per cent purity oxygen which is a second product of the generator. These are not required for the open hearth furnace oxygen.

Besides the instruments and controls shown on Figure 7, additional items will be found at the individual open hearth furnaces, consisting of the following per furnace:

1. Flow indicator, integrator and regulator for the 40 psig burner oxygen.
2. Flow indicator, integrator and dead man control for the 100 psig lance oxygen. A flow regulator may also be installed.

In addition to all of the aforementioned instruments and controls, there are various alarm signals which indicate by a suitable sound and light, conditions that require operational changes. These alarm signals operate when the pressure in the spheres becomes excessive or falls below a predetermined minimum, and when the temperature and pressure of oxygen in either the 50 or 110 psig receiver becomes excessive.

The principal purpose of this extensive instrumentation and control system is to provide adequate means of regulating the storage and distribution of oxygen with a minimum of manual effort. It also has the additional advantage of facilitating accounting for the usage of oxygen and the utilities required for its distribution.

SAFETY

Oxygen is neither an explosive nor a toxic gas as usually defined in safety codes, however, its ability to support combustion increases with its concentration. For this reason, any gaseous mixture containing a high percentage of free oxygen should not be brought in contact with readily combustible materials. It is the prevention of such contact that forms the basis of most of the safety features required by the type of oxygen storage and distribution system as covered in this statement.

The principal combustible materials which are likely to come in contact with oxygen are oil and grease. Consequently, the use of either of these materials on the oxygen end of the compressors and on any of the piping and regulators should be strictly avoided. Since oil or grease cannot be used on the oxygen end of the compressors, reciprocating units should be of the so-called nonlubricated type of construction, where the segmental piston rings and packing are graphitic carbon. As previously stated, the lubrication for all screwed pipe connections should be provided by litharge and glycerin.

Since the presence of some oil and grease for the lubrication of the driving end of the compressors and possibly for the operation of regulators cannot be avoided, a no-smoking rule should be in effect in the building housing the distribution equipment. Also any torch work in the vicinity of oxygen equipment should be carefully supervised and the wearing of oily or greasy clothing when working on oxygen equipment should not be allowed. Finally, the oxygen storage tanks should be isolated by fencing.

Since oxygen is nonexplosive, it is permissible to use open type electric motors for driving equipment. However, this may not be in accordance with the steel works standard.

OTHER USES FOR OXYGEN

By installing an additional fractionating column and heat exchange facilities in the oxygen generating plant, it is possible to produce a small quantity, up to about seven per cent of the plant capacity, as so-called high purity or 99.5 per cent oxygen. This oxygen can replace that being received in cylinders, trailer tubes, or as a liquid in Dewar vessels from outside sources with a considerable saving in cost. In order to realize the maximum savings, a piping and distribution system from the point of generation to the principal users of the high purity oxygen should be provided.

SUMMARY AND CONCLUSIONS

It has been repeatedly emphasized in this statement that attention to local considerations are of the utmost importance in correctly designing a storage and distribution system to supply oxygen to an open hearth plant. However there are certain features of design that apply generally to any plant. These features, which have been discussed in detail are as follows:

1. The sizing of the oxygen generating unit, the storage facilities, and the piping should have as a background actual operating conditions. These conditions should not only indicate the average requirements for oxygen but also the maximum and minimum demand rates.
2. The rate of oxygen production will be relatively constant regardless of the type of generating unit.
3. Storage may be provided in a variable volume gas holder or spherical or cylindrical pressure vessels. The gas holder finds its application where the demand for oxygen is relatively constant. The spherical pressure vessel can be used to advantage when the demand is variable and storage pressure does not exceed 150 psig. Where the demand is variable and the storage pressure exceeds 150 psig then the cylindrical pressure vessels should be used.
4. Unless the average demand exceeds approximately 300,000 cfhr, the oxygen compressors should be of the reciprocating type. If the demand exceeds that figure then, under certain conditions, centrifugal units may be considered.
5. Piping should meet the plant standards for compressed air lines with the additional feature that combustible thread lubricants, gasket material and packing must not be used.
6. Instrumentation and controls should be in sufficient quantity that manual operation is kept to a minimum and that accounting for oxygen usage is provided. Also warning signals for irregularities in operations should be installed.
7. Oxygen must not be allowed to come in contact with any readily combustible material during compression and distribution.

It is the combination of these features together with full consideration of local conditions that form the basis for a correctly designed oxygen storage and distribution system. A system designed on such a basis will result in an adequate supply of the oxygen to the furnaces with a minimum expenditure for facilities and at a low operating cost.

DISCUSSION

PRESENTED BY

MARTIN J. CONWAY, Consulting Engineer, Gap, Pa.

P. W. NUTTING, Inland Steel Co., Indiana Harbor, Ind.

Martin J. Conway: The authors are to be congratulated on the able manner in which they have handled this subject and as they have stated each application should receive individual careful study both for the purpose of establishing oxygen generating plant size together with the necessary storage capacity and degree of flexibility. The latter facilities are the most important from the steel plant operator's point of view.

Fortunately, oxygen generating units are available in capacities to suit any steel plant requirement, varying in size from a few tons per day up to 1000 tons per day. Fortunately also, storage which may be suitable for certain established types of operation may be added to or rearranged to suit later conditions, or plant additions, but as the authors have so aptly pointed out, a sizeable saving in initial investment can be made if a thorough test is conducted under expected operating conditions prior to purchase of oxygen plant and storage.

These tests, of necessity, consume several months and in some cases up to a year, and while the investment in this research program is in most cases, self liquidating, it does involve considerable investment in the purchase of oxygen, which possibly could be supplied by the purchase of a small oxygen plant — say of 10 or 15 tons per day capacity, with an adequate amount of storage which could later form part of the permanent plant. The differential between the purchased oxygen cost and the cost of the oxygen generated locally would go a long way toward liquidating the cost of the initial investment in the smaller experimental plant and at the same time leave the small plant as an operating unit in case of the larger plant shut-down for any reason. In addition it would serve as a training period for the permanent plant operators.

I may add, that in my opinion, there will be several occasions during the lifetime of the combined operation of oxygen generating plant and storage, when a small low pressure holder will be a convenient tool to have around, and possibly this would form the basis of the storage when the small experimental plant is installed.

I may enlarge a little on instrumentation in that it is advisable to have total shop flow and pressure recorders in the open hearth in order that the melter or other responsible personnel may know the condition of the storage at all times as with this information available to them continually, they can more readily anticipate oxygen consuming conditions which will help the oxygen generator operators and prevent avoidable swings in the generator output.

P. W. Nutting: I would like to call attention to this same problem as it presents itself to us at No. 2 open hearth at Inland Steel Co. In presenting our problem, I will follow through the same general reasoning that the authors used in their paper, and I will attempt to show that while the authors' conclusions as to generating capacities and storage facilities, are in the main correct, actual operating conditions may require some very definite revision in the plan as just presented.

PRELIMINARY DESIGN DATA

Number of furnaces in plant	24
Weight of heats	176.0 (average)
Average time of heats, tap to tap — hr	12.91
Oxygen for flame enrichment — cu ft per ton ingots	270
Average time oxygen used for flame enrichment —hr	2.35

Oxygen for decarb — cu ft per ton ingots.....250
Minimum oxygen pressure at lance — psig.....100
Average time oxygen used for decarburizing bath — hr.....1.10

The average demand for oxygen over a random twelve hour period in No. 2 open hearth was found to be 140,000 cu ft per hr; the peak demand was found to be 380,000 cu ft per hr; the minimum demand was found to be 20,000 cu ft per hr. On the basis of average hourly demand — the minimum required generating capacity for an oxygen plant for our shop would be 5.8 tons per hr and it would be necessary to have storage capacity to supply 15.8 tons per hour for peak demand.

The peak demand noted above came in a period where demand had exceeded generating capacity for four hours and forty-five minutes. If this plant were designed to generate 5.8 tons of oxygen per hour as suggested by the authors, then during this period the open hearth would have consumed a total of 360,000 cu ft in excess of the generating capacity. This amounts to approximately fifteen tons of oxygen or an increase of almost 150 per cent of storage capacity in excess of that which would be provided on the basis of the author's calculations.

This data is presented, not in an effort to discredit the author's calculations or methods of presentation, but rather to show that under actual operating conditions, it is necessary to provide for oxygen generating capacities or oxygen storage facilities far in excess of what might be normally expected. During the past years, it has not been unusual to find periods when peak demands in our shop exceed 500,000 cu ft per hr and there have been frequent periods when no oxygen was being consumed. This indicates the scope of the problem involved in constructing and operating an oxygen plant solely for the purpose of providing metallurgical oxygen for an open hearth shop.

THE TRAINING AND DEVELOPMENT OF PERSONNEL*

▲ THE training of personnel starts with the proper selection of employees and their assignment to occupations for which they have satisfactory physical, mental and temperamental qualifications and interest. To attain this end it is necessary to have a staff of competent interviewers and training personnel, along with a well-equipped infirmary and medical staff.

Of paramount importance in the indoctrination of new employees is instruction in our safety program. This is training which must have an early beginning, but never an ending. Industry can look with some pride upon the general improvement in its safety record through the years but progress must be accelerated through increased effort by management and greater interest on the part of the workers. Our accident prevention program followed conventional lines. We recognized that the bulk of our people were new to industry; we knew that they would need intensive early training, and such training was provided. We then continued along the usual route with safety meetings, slogans and the usual attention to the details of safety. But this was not enough. Our experience has led us to believe that a high I.Q. does not necessarily mean an early entrance into the area of safety consciousness. We are now convinced that we should be more intensive in our efforts, and this we are doing through more attention to accident investigation, safety meetings, and individual contacts.

The question might well be asked. "Why are individuals of good training and education susceptible to accidents in industry?" My answer may be thought trite, but I believe it true — "It is difficult to find a substitute for experience."

We look to the foreman, the first line supervisor, as the mainstay, in keeping our work force united and informed. As time has passed, we are becoming convinced that we should have given greater emphasis to this aspect of supervision earlier in our history — at least we didn't do all we might have to help development in this line. We tend to be too concerned with production and not enough aware of our supervisors' basic needs.

Our supervisors have been offered formal training in accident prevention techniques. They are now, through the efforts of the training division staff, being coached and tutored in the techniques of conducting effective meetings. This current program is, we believe, one of our most positive strides ahead, since it is helping the majority of our supervisors to analyze their personnel and operations problems in such a way that they can prepare instruction and offer it to their men in short, well organized meetings. This program is creating an effective channel of communication from management to our employees which may be used for many purposes. Constant follow-up on the part of our training instructors is proving to be of value in reaching stated objectives in this program.

In addition to conducting supervisory training, we have attempted to meet other known needs. The training of employees generally has been aided somewhat by various technical and semi-technical courses which have been sponsored. For example, training has been offered in "Battery Care and Maintenance," and "Care and Use of Files and Cutters." Recent months have seen the completion of programs dealing with problems of lubrication, electronics, instrumentation and other comparable subjects. Employees who can profit from this type of training are normally permitted to enroll.

Apprenticeship training has occupied an important position in our program at Geneva. There had been very few skilled craftsmen produced in the area who had been trained in heavy industry comparable to ours. When Geneva began its peace-time operation, an apprentice training program was begun for the purpose of filling existing vacancies in our work force. At present, we have 109 young men enrolled in this program, all of whom are high school graduates or equivalent, and many of whom have completed one or more years of college training. This program is undergoing constant growth.

*Abstracted from paper of same title presented by L. J. Westhaver, Vice-president and Manager of Operations, Geneva Steel Co., at San Francisco Regional Technical Meeting of AISI, November 10, 1950.

ROLLING SOLUTIONS FOR SPECIALTY STEELS

By MAXWELL L. BIBLE
General Foreman Cold Strip Mill
Crucible Steel Co. of America
Midland, Pa.

. . . . one of the most important aspects in the operation of a rolling mill is proper attention to the rolling lubricants and coolants . . . .

▲ THE total friction in any rolling operation can be divided into two main components: that of the resistance of the metal to deformation or internal friction, and the surface friction of the roll against the metal surface or external friction. From the standpoint of the rolling lubricant, nothing can be done about the internal friction; but a great deal can be done about the surface friction.

Rolling lubricants which are applied neat, without water, provide the greatest reduction in coefficient of friction, since fluid film lubrication conditions do not exist, because of the extremely high pressures, and boundary lubricants must be used. Extreme pressure lubricant additives, such as sulphur, chlorine, and the like are undesirable in rolling of stainless steels; but the "fatty" type boundary lubricants possess the necessary qualities—such fats as degras (lanolin), palm oil, sperm oil, lard oil are excellent boundary lubricants, and these properties can be improved by special processing.

In rolling of stainless steels, the neat application of such fats can give enough lubrication to interfere with the bite of the rolls and with surface luster; hence, it is common practice to reduce the lubricating ability of the fat by dilution with mineral oil when the rolling lubricant is to be applied without water. Unfortunately, oils are very inefficient coolants as compared with water which is several times better than oil as a coolant. The necessity for rapid heat removal is a paramount consideration in any rolling operation. As the requirement for lubricating and cooling is localized in the same area, dual application facilities must be provided; or the lubricant must be dispersed in the cooling water. This latter method seems the most logical but brings with it several problems.

A dispersion of oil or fat is properly called an emulsion. The friction reducing properties of such an emulsion can never equal the friction reducing properties of the dispersed lubricant; hence, only the best boundary lubricants, such as the fats above mentioned, without dilution with mineral oils are preferred when water is present. An emulsifier is required to secure a uniform, stable dispersion of fat in water. This emulsifier must be such as to deliver a uniform dispersion of fat in the cooling water to the mill; yet this emulsion must not be so stable that the fat will not plate out on the rolls and metal, as different degrees of stability are obtained with the same emulsifier in varying water hardnesses and at different temperatures, the only sure method of judging emulsion stability is with the water to be used and at the operating temperatures of the emulsion.

There are other considerations such as the foaming tendencies of the emulsifier, the ability of the rolling emulsions to wet rolls and metal, the freedom from staining effects, the absence of materials that might interfere with subsequent annealing and pickling operations; thus, a good emulsifiable fatty type rolling lubricant is obtained only after careful consideration of all factors by the lubricant manufacturer and the mill personnel.

The concentration of rolling lubricant to be used in the emulsion can be determined only by a carefully controlled test. A good starting point is to prepare the emulsion so that it contains 5 per cent fats. This fat content can then be varied until optimum operating conditions and economy are obtained.

Proper attention to the rolling lubricants and coolants is one of the most important aspects in the operation of a rolling mill. Daily checks should be made on the emulsion, and a record kept of temperature, concentration, pH value and solution level in the tanks. Solution should be kept to indicate a pH value of approximately eight. This will be true of the initial water in charging a new tank concentration, to prevent metal to metal contact under all load and temperature conditions. Concerning the life of the emulsion, this depends on the amount of usage, usually 1 to 2 per cent of oxides or mill greases should be the maximum and will appear in the flotation on top of the tank. The tank should be periodically skimmed to remove and delete scum and mill residues from top of tank. If this is not done, the flotation at times becomes heavy and breaks away from the aggregate and passes through to the mill. In any case, when dealing with a product such as stainless, the cost of maintaining a stable solution is cheap insurance.

The processing of stainless steels are divided into three operations which are breakdown, intermediate, and finish rolling.

The breakdown operation, as commonly called, is

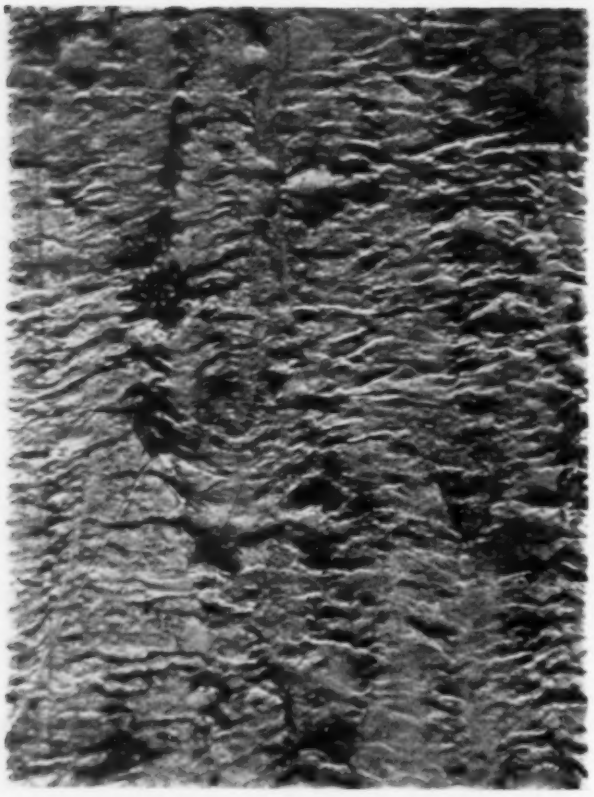


Figure 1 — Photomicrograph shows disturbances in surface finish when solution is not stable enough to withstand the pressure.

usually rolled on tandem mills where approximately 50 per cent reductions are made and the surface friction and heat generated are at their greatest heights; therefore, the emulsion concentration must be stable enough to prevent metal to metal contact and adequate coolant to dissipate the heat. The writer recommends from practical experience, a total concentration of fats and emulsifier to be between 12 and 18 per cent by the Babcock or acid test, and a temperature of the emulsion of 90 F coming to the mill. He also recommends a 10,000-gal reservoir for a 3-stand, 56-in. four high tandem mill with pumps delivering 1000 gpm at 80 psi pressure through 3-in. lines to eight headers per stand — two on top and bottom on entry side of mill, two on top and bottom on exit side of mill, with twenty duck bill sprays to each header and one header to spray emulsion to point of contact of back up roll and work roll, one header to spray emulsion to point of contact of work roll bite. One quarter in. openings in the duck bill sprays are necessary to prevent too much impingement or splash back of emulsion on strip that quickly evaporates the water and leaves a solid portion of fat to enter the rolls with resultant rolling into surface of the strip and interference with subsequent annealing and pickling operations.

Intermediate rollings are usually 35 to 40 per cent reduction to within a few thousandths above finish gage and would be classified in the same category as the breakdown operation.

Finish rollings are usually given 15 to 20 per cent reduction after intermediate rolling on high finish ground rolls to develop surface finish on strip suitable for buffing or electro-polishing. Rolling solutions for this operation are the most important of all operations in the manufacture of stainless steels because of the necessity to transfer roll luster to strip surface. The lubricant must be a low viscosity oil with enough fatty additives to prevent metal to metal contact under fairly extreme pressures.

Figure 1 is a photomicrograph at one thousand magnification and shows where the solution was not stable enough to withstand the pressure. The film failure caused metal to metal contact and frictional disturbances between roll and strip. Note the aggregates of microscopic surface ruptures or declevities at right angles to the direction of rolling. They tend to cause heavier scaling in annealing and poor pickling quality, as well as poor buffing quality. The roughness characteristics as shown by "brush" surface analyzer, gives for the approximate maximum peak to valley roughness a value of twenty-four micro inches; and the number of valleys per linear inch is approximately nineteen hundred.

The lubricant also must have the fatty additives well dispersed or an undiluted portion could cause serious problems as shown in Figure 2 also at one thousand magnification. Note the surface crevices at right angles to the direction of rolling. This also tends to heavy scaling and poor pickling quality.

Figure 3 also at one thousand magnification, shows the proper dispersion of fatty additives in the rolling lubricant. Note the absence of transverse ruptures or declevities which is an excellent annealing and pickling surface to produce a very good buffing or electro-polishing quality strip. The approximate maximum peak to valley roughness is three and one-half micro inches. The number of valleys per linear inch is approximately eight hundred.

A good finish rolling lubricant consists of about 85 per cent mineral spirits of the Pennsylvania grade which is a low solvency material, 5 per cent of a heavy viscous oil similar to Pennsylvania cylinder stock and 10 per cent of "fatty" materials which would give approximate viscosity at 100 F of 36 seconds (saybolt universal). Other properties are as follows:

a. Flash point (open cup) — 134 F.
b. Saponification value — 17 to 18.

Figure 2 — Bad dispersal of fatty additives create serious problems.

Figure 3 — Photomicrograph illustrates that the fatty additives in the rolling lubricant are dispersed properly.

c. Surface tension — 26.8 dynes.
d. Specific gravity at 60 F — 0.8116.

A good water soluble lubricant for breakdown operation consists of the approximate materials:

a. Total fats — 15 per cent (by babcock test).
b. Soap — 4 per cent.
c. Free fats — 11 per cent.
d. Water — 85 per cent.
e. Specific gravity at 60 F — 0.9859.
f. pH value — 8.

A fatty oil emulsifier will emulsify more readily fatty oil in solubles and leave a carbonate ash which will not cause acid spotting of chrome-nickel strip and interfere with subsequent annealing and pickling operations.

DISCUSSION

PRESENTED BY

PAUL DOYLE, Industrial Waste Corp., Cleveland, Ohio

MAXWELL L. BIBLE, General Foreman, Cold Strip Mill, Crucible Steel Co. of America, Midland, Pa.

JOSEPH D. LYKINS, Chief Lubrication Engineer, Wheeling Steel Corp., Wheeling, W. Va.

H. GREY VERNER, Director of Research, R. H. Miller Co., Inc., Homer, N. Y.

J. D. ROWBOTHAM, General Maintenance Foreman, Cold Strip Mill, Youngstown Sheet and Tube Co., Youngstown, Ohio

A. C. STARLING, E. F. Houghton & Co., Philadelphia, Pa.

C. E. PRITCHARD, Chief Lubrication Engineer, Republic Steel Corp., Cleveland, Ohio

Paul Doyle: I was particularly interested in that part of Mr. Bible's paper referring to the use of vegetable oils, either straight or as an emulsion, to obtain the results he has mentioned in his paper. I personally am of the opinion that the performance obtained with these oils is directly associated to the polar characteristics of the fatty products used.

I would like to stop here and ask a question of Mr. Bible as to his preference for the types of fats he used to obtain the results he has mentioned?

I would like to mention that quite similar results were obtained under practically the same type of conditions by using a rolling oil. These rolling oils, then, it might be said, if properly prepared as to their polar characteristics, are somewhat similar to what you find in your fatty materials. It is my opinion that your rolling oils on cold roll steel, taking a straight mineral oil and applying it to the roll, would orient themselves to almost any habit formation.

Take a mineral oil that has been properly prepared to contain a polar compound. I believe they react quite similarly to the fatty oil molecules, and then orient themselves to that peculiar position which enhances greatly their affinity to stick to metal. This makes it possible to use these type mineral oils through cold rolling and obtain quite similar results as you would with your fatty materials. I am talking with respect to mineral oils not being in the emulsified form, for that is applied to separate fluid and water.

Maxwell L. Bible: Every mill has its own particular ways and methods of rolling lubricants. I like a mineral oil where you develop high finishes on stainless strip. I like lanolin additives better than vegetable oil, but in water soluble, we find that you get greater reductions because, as I explained in the paper, it is a dual application, wherein you have to dissipate the heat and get the lubricating ability at the same point. I find that your fatty materials, with a soap type emulsifier, emulsifies more readily and, as I said, leaves a carbonate ash which does not stain or etch the material in subsequent annealing and pickling operations.

In rolling a low carbon strip, I agree with the gentlemen that mineral oils do have a good lubricating ability, that water can be applied at some points, and it does not have to enter the roll's cooling facilities. Where you do have to have a dual application of lubricants and water at the same area, I find that the vegetable oils do work very well on stainless applications.

Non ionic emulsifiers have not been tried too extensively in rolling operations of this type because they are somewhat unstable at the elevated rolling temperature and also because they are considerably more costly than the soap type emulsifiers.

Member: They are twice as expensive and you might use them only one-tenth as long. There is usually no ash. The material, in subsequent annealing and pickling, will leave edging or etched surfaces on your chrome nickel materials.

Joseph D. Lykins: Do you think the cleaning and wetting ability of a rolling oil is its most important property for keeping the mill and strip clean?

Maxwell L. Bible: That goes back to the lubricant manufacturer. They do have enough material added to make a good detergent for cleaning and wetting out rolls and metal.

H. Grey Verner: I wonder, Mr. Doyle, if you are prepared to be specific in mentioning the additives that you would add to lubricating oil to make it act like a vegetable oil?

Paul Doyle: The product, as referred to, is an acidic product of controlled oxidation.

J. D. Rowbotham: We have heard a lot of talk about oil here, and how we are trying to improve the oil, but what has been said about the method of application whereby 90 per cent of the oil could be saved or reduced in consumption? What has been done about that? Has anybody given it any thought?

Maxwell L. Bible: We are using a circulating system or what is called a closed system whereby you run the material through a filter and cooler.

J. D. Rowbotham: In cases where a circulating system is not used, and you use water and oil too, the water carries off the greater portion of the oil. What do you do in that case?

Maxwell L. Bible: A thin application is a good method for that, applied to the point of contact of the work roll bite, either by the spraying or dripping method, whichever you would like. Then try applying water under pressure to exit side of rolls and block off water with a wiper on strip before entering next mill.

A. C. Starling: What effect does the use of palm oil and water have on stainless steel rolling?

Maxwell L. Bible: There is considerable on the rolling of tin plate. There are other applications other than on stainless steel. I have not had too much experience with the straight applications of palm oils and water coolant other than in break-down operations. We find that the material does give good lubricating ability, but it does have some staining effect due to the palmatic acid in subsequent annealing and pickling operations.

C. E. Pritchard: It was mentioned that you employ three separate and distinct stages of reduction during the rolling of stainless strip. Do you mean to infer that you use the same product during all three rolling stages or that you use different products?

Maxwell L. Bible: We use the same product for all operations.

RELATIVE CHARACTERISTICS OF SPEED CONTROLLING AND SPEED REGULATING SYSTEMS*

D-C Motor with:	Relative cost, per cent	Speed range	Speed regulation	Relative size, per cent	Relative weight, per cent	Maintenance	Applications
1. Rheostat	100	4/1	10/25%*	100	100	High	Constant-horsepower: machine tools, lathes, planers, and drill presses.
2. Motor generator	180	40/1	10/25%*	200	200	Lower	Constant-horsepower and constant torque: tandem drives, steel mills, paper mills, textile mills, and rubber mill conveyors.
3. Motor generator with exciters	200	40/1	10/25%*	225	225	Lower	Same as Item 2.
4. Motor generator with rotating regulators	250	120/1	±1%	225	225	Lower	Same as Item 2.
5. Motor generator with electronic regulator	300	120/1	±0.1%	210	210	Similar to Item 2 except for tubes	Paper machines and rod mills.
6. Motor generator with magnetic amplifier	250	120/1	±1%	225	225	Lowest	Same as Item 2.

*Approximate values which may vary, depending on the motor and generators used.

▲ A summary of the relative characteristics of these different speed controlling and speed regulating schemes is presented in above Table. The table is based on the average values for a 5-, 25-, 50-, 100-, and a 200-hp motor, each having a speed of 400 to 1600 rpm.

The d-c motor with a rheostat is assumed to be 100 per cent, and all other combinations are compared to it.

Increased speed both from a labor cost and improved quality of product is becoming more and more important. The electrical industry, with improved regulators, has made the individual drives on various processing lines possible. While rotating regulators will continue to be used where the speed regulation is not too critical, the electronic regulator will have to be used where very close speed regulation is required. However, with the improvement in magnetic materials and rectox units, the magnetic amplifier will be more generally used because of performance and reduced maintenance.

Above is abstracted from paper "Motor Control — Rotating, Electronic, and Magnetic," by C. P. Croco, Manager Application and Project Section, Westinghouse Electric Corp., at Westinghouse Electric Corp.'s "Trends of Electric Power in Industry" Conference, on April 19, 1951, at East Pittsburgh, Pa.

A NEW PROCESSING SCALEBREAKER

By J. I. GREENBERGER
Research and Development Engineer
United Engineering and Foundry Co.
Pittsburgh, Pa.

. . . . the new processing scalebreaker, which utilizes the advantages of small rolls, reduces pickling time and diminishes acid requirements . . . .

▲ PRESENT hot rolling practice as applied to ordinary carbon and stainless steels makes mandatory a scale removing operation prior to subsequent cold rolling. Oxidation occurs rapidly at the high finishing temperatures of hot rolling, and it is this oxide coating which must be completely removed in order to maintain high standards of surface quality and absence of porosity in the subsequent cold rolling operation.

Type, thickness and distribution of hot rolled scale is affected by many factors which, as pickle line operators well know, result in considerable variation in ease of pickling. This is particularly evident when pickling hot rolled strip obtained from different sources. Modifications of rolling practice on even the same hot mill will change the pickling rate on the same steel grades. A major scale controlling factor is hot coiling temperature. Close coupled mills, with inadequate length of run out table or other cooling facilities, mean high coiling temperatures, slow cooling of the hot coils, and a tough tight scale. Steel chemistry is another factor affecting type of oxide formation. There is also a normal variation between oxide conditions at the edges and center of strip due to both the ability of air to permeate through at least the edge zones of the hot rolled coils as well as the temperature gradients through the cooling coils which result in quicker edge cooling. Since the subject of specific scale formation is beyond the scope of this paper, it will not be further discussed beyond stating that great variation in hot rolled scales and ease of pickling does exist.

Through years of research and practical development, a fairly standardized pickling procedure has evolved for removal of the hot rolling scale. Early continuous pickling lines consisted of a series of hot sulphuric acid baths followed by water rinsing and hot air drying. Suitable uncoiling and joining means were necessary at the entry end with usually shearing and coiling facilities at the delivery end. Recently installed continuous pickling lines differ basically only in the addition of scalebreaking means at the entry end of line and higher line speeds.

Without attempting to explain the pickling mechanism as it occurs during scale removal in hot sulphuric acid baths, it has been generally accepted that it is the action of the acid at the zone of demarcation between the base metal and the innermost oxide layer that causes lifting off of the scale particles. Since a pickled coil passes inspection over its entire surface area, pickling rates are automatically restrained to speeds compatible with removal of the worst scale areas in the strip. Acid baths can be controlled either by concentration or temperature to most effectively pickle off a given scale condition, but obviously a tight unbroken scale with few passageways for the acid to get to the interface zone of demarcation will be difficult to remove.

A scale breaking process to mechanically crack the scale prior to pickling provides many passageways for acid attack, thus both speeding up the rate of pickling and also physically removing some oxide film. Several mechanical scale breaking methods are possible, all of which take advantage of the low ductility of the oxide film. Continuously stretching the full strip cross section taking a slight cold reduction in a conventional rolling mill and flexing the strip around rolls are the more familiar possible mechanical scale breaking methods. The continuous stretching process would require massive equipment to be able to take typical $\frac{1}{8}$ to $\frac{3}{16}$ in. thick hot rolled strip above the yield point. Cold reduction as a scale breaking process, which is common practice for type 430 stainless, utilizes expensive rolling facilities and a separate operation, and also results in rolling in some of the finely broken scale. Flexing the

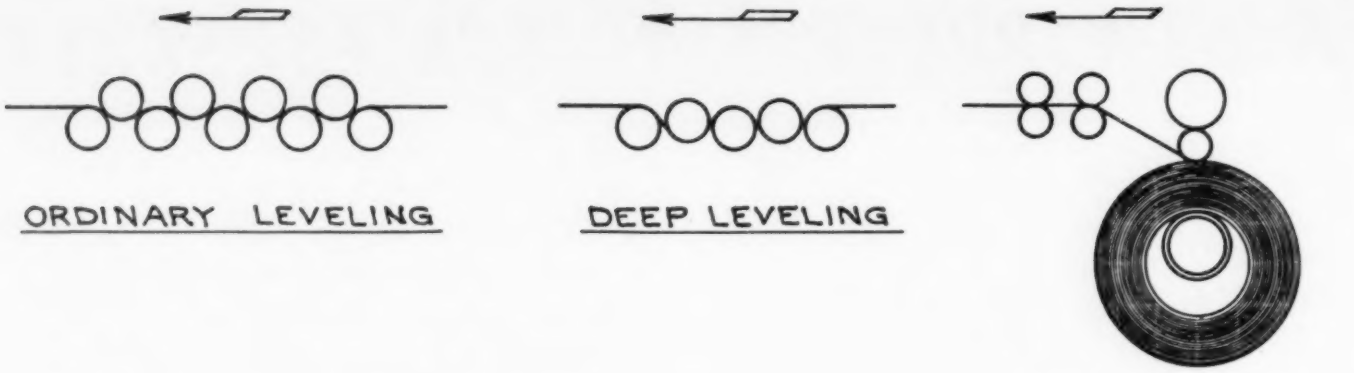


Figure 1 — Typical present day flexing scalebreakers are given in this sketch.

strip would therefore appear to be the proper method to be used in seeking an answer to the mechanical scale breaking problem.

Many flexing processes are possible. The basic requirement of a successful flexing operation is that sufficient strain be introduced into the outer strip fibres to exceed the ductility of the scale. Ordinary leveling, deep leveling, and a familiar type of scalebreaker are typical present day flexing processes and are illustrated in Figure 1. These typical flexing units have certain important design limitations which will now be examined. Our new processing scalebreaker successfully circumvents these limitations.

There seems to be no fundamental data available on the ductility of the various oxides and it will be necessary to draw conclusions from laboratory and field tests. As shown in Figure 2, the per cent outer fibre strain present when flexing strip of thickness "t" around a roll of diameter "D," can be approximately expressed as plus or minus t/100D. The problem of correlating actual outer fibre strain in terms of quality of scalebreaking was approached by first conducting laboratory tension and pickling tests on hot rolled unpickled strip specimens, which tests revealed that appreciable strains were involved before sufficient scale breaking occurred to speed up pickling. Next step was the flexing of 2-in. wide strip specimens around various small diameter bending rolls in an experimental machine having the nested construction shown in Figure 2. It was established that first, a definite relationship existed between outer fibre strain (t/100D ratio of the flexing operation) and the degree of scalebreaking and consequently rate of pickling, and second, improvement in degree and quality of scalebreaking was obtained by additional reversed flexing of the strip.

Typical effects of outer fibre strain on the pickling characteristics of a particular 0.049-in. thick hot rolled low carbon steel strip are shown in Figure 3. Pickling time decreased from nearly 4¾ minutes in the as hot rolled condition to about one minute after two bends of about 3½ per cent strain. As a ratio, this corresponds to almost five-fold speed up in rate of pickling. Field tests on an experimental 8-in. strip width and 750-fpm, two-bend scalebreaker confirmed this relationship. Effect of the additional reversed flexing of strip is also illustrated in Figure 3, which shows that the outer strip fibres move through twice the indicated t/100D per cent strain. It was noted that reversed flexing in the second bending set increased the amount of scale removed over single flexed strip subjected to the equivalent total outer fibre strain. Typical of the amount of actual scale removal was the 50 to 80 per cent as visually estimated after a two-bend flexing operation having 2½ per cent t/100D strain in each bend set. Similar pickling speed up and actual scale removal was obtained in tests on type 430 stainless steel strip as well as low carbon steel strip.

Field tests on the 8-in. strip width experimental two-bend processing scalebreaker yielded the data shown in Figure 4. Note the considerable total input power required when using high t/100D per cent strains. Also note the permanent elongation imparted to the strip by the two bend operation. The power data of Figure 4 for any desired t/100D per cent strain condition may be converted for any strip thickness, width and speed combination by the following formulae:

For low carbon steels:

Total input power =

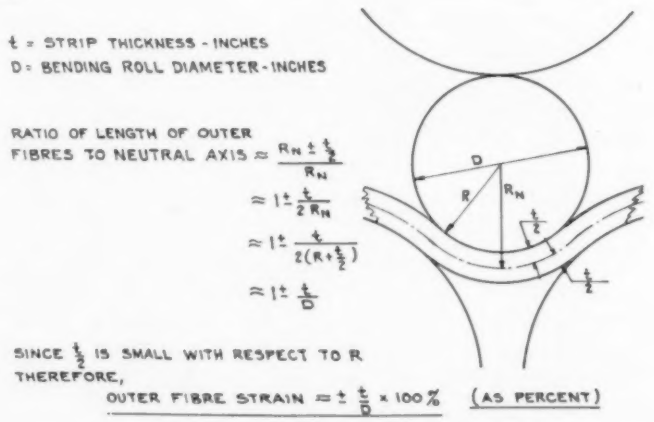
$$\text{power value (Figure 4)} \times \frac{t}{0.049} \times W \times \frac{V}{100} \qquad (1)$$

For type 430 stainless steels:

Total input power =

$$\text{power value (Figure 4)} \times \frac{t}{0.122} \times W \times \frac{V}{100} \qquad (2)$$

Figure 2 — Outer fibre strain is approximately equal to $\frac{t}{D}$.


t = STRIP THICKNESS - INCHES
D = BENDING ROLL DIAMETER - INCHES
RATIO OF LENGTH OF OUTER FIBRES TO NEUTRAL AXIS ≈ $\frac{R_N \pm \frac{t}{2}}{R_N}$
≈ $1 \pm \frac{t}{2R_N}$
≈ $1 \pm \frac{t}{2(R+\frac{t}{2})}$
≈ $1 \pm \frac{t}{D}$
SINCE $\frac{t}{2}$ IS SMALL WITH RESPECT TO R
THEREFORE,
OUTER FIBRE STRAIN ≈ $\pm \frac{t}{D} \times 100\%$ (AS PERCENT)
D
R
R_N
$\frac{t}{2}$

where: t = strip thickness — in.
W = strip width — in.
V = line speed — fpm

For example, assuming a desired pickling rate on a low carbon steel corresponding to two bends of outer fibre strain of 2.5 per cent and say 36 × 0.090 in. strip at 400 fpm (power value from Figure 4 is 1.04).

$$\text{Total input power} = 1.04 \times \frac{0.090}{0.049} \times 36 \times \frac{400}{100}$$

$$= 275 \text{ hp for two bends}$$
$$= \text{Say } 150 \text{ hp per bend set.}$$

Similar power calculations may be based on Figure 5 which removes the strip thickness factor from equations (1) and (2) by using $\frac{100t^2}{D}$ instead of $\frac{100t}{D}$ for the abscissa. Note that this curve also shows that type 430 stainless with its slightly higher yield point required proportionately higher total input power than low carbon steel for the same $\frac{100t^2}{D}$. The theoretical power relationships for the new processing scalebreaker are developed in Appendix I.

The relatively high strains to which the outer strip

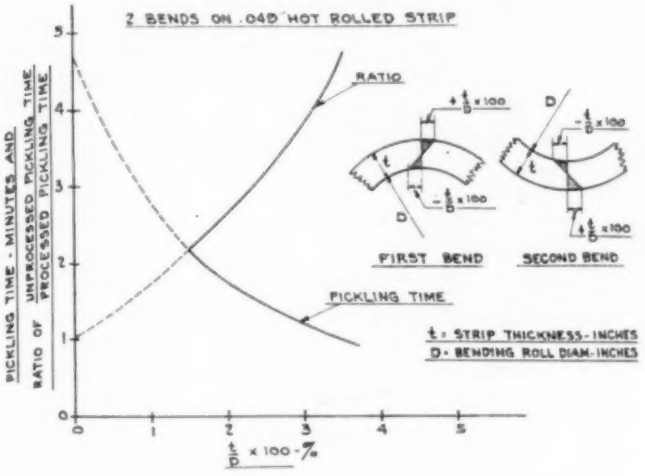

2 BENDS ON .049" HOT ROLLED STRIP
RATIO
PICKLING TIME
FIRST BEND
SECOND BEND
t = STRIP THICKNESS - INCHES
D = BENDING ROLL DIAM. INCHES
PICKLING TIME - MINUTES AND RATIO OF UNPROCESSED PICKLING TIME / PROCESSED PICKLING TIME
t/D × 100 - %

Figure 3 — Increasing outer fibre strain reduces pickling time.

fibres are and can be subjected to in the new scalebreaker result in strip hardness increase which analysis will show has no significance in the great majority of applications, since subsequent cold rolling eliminates this factor. Figure 4 shows that specific permanent strip elongations take place which correspond to practically equivalent reductions in strip thickness. Thus 0.100 in. thick hot rolled strip subjected to the two bend processing scalebreaker and receiving 3 per cent elongation becomes 0.097 in. thick. Surface hardness increase for these conditions would vary between 10 to 15 points Rockwell B. Since the first pass of the following cold rolling operation would vary between 30 to 50 per cent, it would seem that this surface hardening of the scalebreaking operation would have little practical significance. To confirm this, forty identically hot rolled low carbon steel coils were scalebroken, pickled and cold

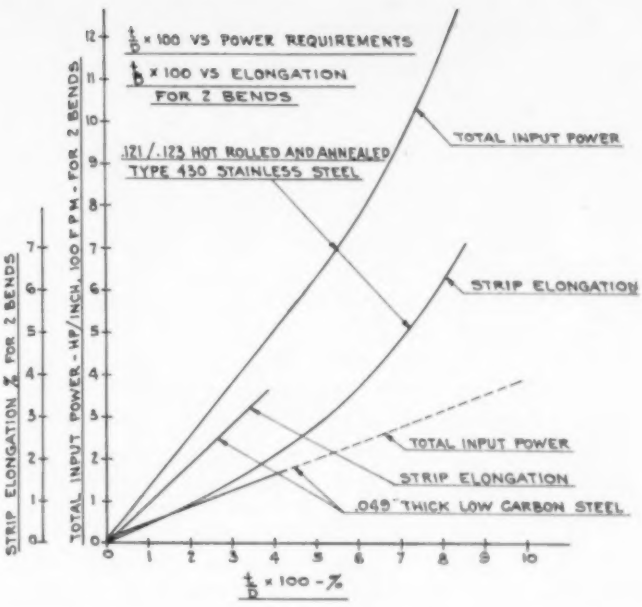

t/D × 100 VS POWER REQUIREMENTS
t/D × 100 VS ELONGATION FOR 2 BENDS
.121/.123 HOT ROLLED AND ANNEALED TYPE 430 STAINLESS STEEL
TOTAL INPUT POWER
STRIP ELONGATION
TOTAL INPUT POWER
STRIP ELONGATION
.049" THICK LOW CARBON STEEL
STRIP ELONGATION % FOR 2 BENDS
TOTAL INPUT POWER - HP/INCH, 100 F.P.M. - FOR 2 BENDS
t/D × 100 - %

Figure 4 — Curve gives ratio between outer fibre strain and power requirements.

rolled under controlled conditions. Ten coils were scale broken in the two bend processor with $\frac{100t}{D}$ of 3.25 per cent, ten with $\frac{100t}{D}$ of 2.17 per cent, ten with $\frac{100t}{D}$ of 1.64 per cent and the final ten were not scalebroken at all. Hardness increase varied to as high as 15 points Rockwell B and pickling speeds increased as a function of $\frac{100t}{D}$ as shown in Figure 3. All forty coils originally identically thick in the, "as hot rolled condition," were then cold rolled on a reversing cold mill so that the same strip thickness was obtained after the first pass of approximately 45 per cent. After this first gage equalizing pass, all forty coils had identical hardnesses. Thus our contention that hot rolled strip, which is to be cold rolled to some final thickness prior to actual usage, will not be affected by the surface hardening action is confirmed. This surface hardening would only be detrimental if the pickled strip were to be directly used for punchings and deep drawing operations such as for condulet box manufacture. Actually, from the metallurgical and rolling viewpoints, it may be argued that the small amount of cold working which can be performed on the processing scalebreaker serves to equalize the initially variable physical properties of the hot rolled coils, thus delivering a coil of more uniform properties to the cold mills.

Proceeding to the physical aspects of the processing scalebreaker having a bending roll diameter range compatible with present hot rolled strip thicknesses and able to provide proper outer fibre strains, assume 0.050 in. minimum and about 0.150 in. maximum typical hot rolled gages and allow a maximum $\frac{100t}{D}$ of 3.5 per cent in each bend of a two bend scalebreaker. The 0.050-in.

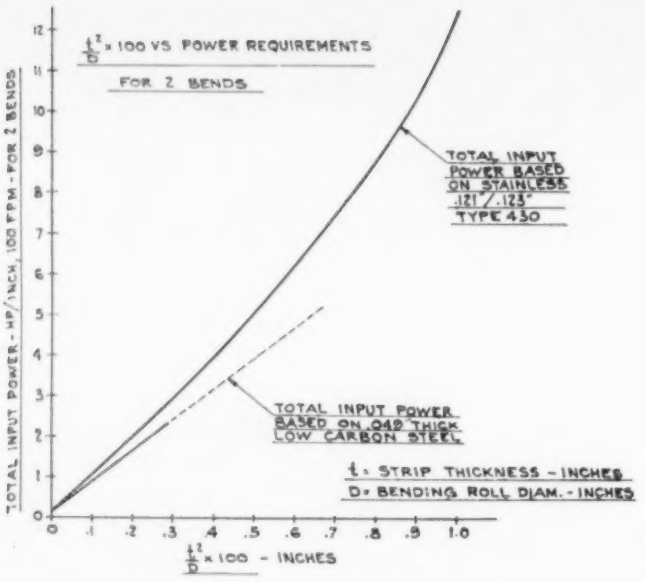

$\frac{t^2}{D} \times 100$ VS POWER REQUIREMENTS
FOR 2 BENDS
TOTAL INPUT POWER - HP/INCH, 100 FPM - FOR 2 BENDS
TOTAL INPUT POWER BASED ON STAINLESS .121"/.123" TYPE 430
TOTAL INPUT POWER BASED ON .049 THICK LOW CARBON STEEL
t = STRIP THICKNESS - INCHES
D = BENDING ROLL DIAM. - INCHES
$\frac{t^2}{D} \times 100$ - INCHES

Figure 5 — Curve gives ratio between total power required and $\frac{t^2}{D}$.

strip and 3.5 per cent $\frac{100t}{D}$ requires bending roll diameters of $D = \frac{0.050 \times 100}{3.5} = 1.48$ in. or say 1½ inches, while the 0.150 in. strip would require $D = \frac{0.150 \times 100}{3.5}$ = 4.29 or say 4½ in. Since less severe $\frac{100t}{D}$ ratios will also be used on the same machine, the full bending roll diameter range would probably be 1½ to 6 inches. Small diameter bending rolls, particularly on wide machines, have little bending resistance, so the nested construction shown in Figure 6 was developed to provide complete backing so that very small bending rolls may be successfully used. As a result of the nested construction, the strip curvature corresponds to the bending roll diameter. Without sufficient backing in all directions for the bending rolls, the present flexing types of scalebreakers such as shown in Figure 1 are physically constrained to larger bending roll diameters and usually far too low $\frac{100t}{D}$ per cent or outer fibre strain ratios. There is also considerable doubt as to whether the strip assumes the curvature of the bending roll diameters in the present flexing type scalebreakers.

Three potential driving arrangements of each nested bending roll set are shown in Figure 6. Case A, with a single back-up roll drive, has the obvious disadvantage that with only one effective driven bite, the holddown pressure must be twice as great as for cases B and C. Case B, with two driven back-up rolls and two effective driven bites, has the problem of matching roll diameters and introduces a pinion stand type drive. Case C, with driven work roll and two effective driven bites, may be used until very wide strip widths demand torque values beyond the torsional strength of small bending rolls. Bending roll assembly design permits complete change of bending roll diameters in a matter of minutes. Thus for the first time, it is possible to quickly vary bending roll diameters in a processing scalebreaker so that for any strip thickness range, the proper and adequate $\frac{100t}{D}$ strain factor is under control of the operator. Once the general $\frac{100t}{D}$ per cent factor has been established for a given pickling installation, strip of all gages may be assured the same degree of scalebreaking and the same quality of pickling. This flexibility of choice of bending roll diameters also makes it possible

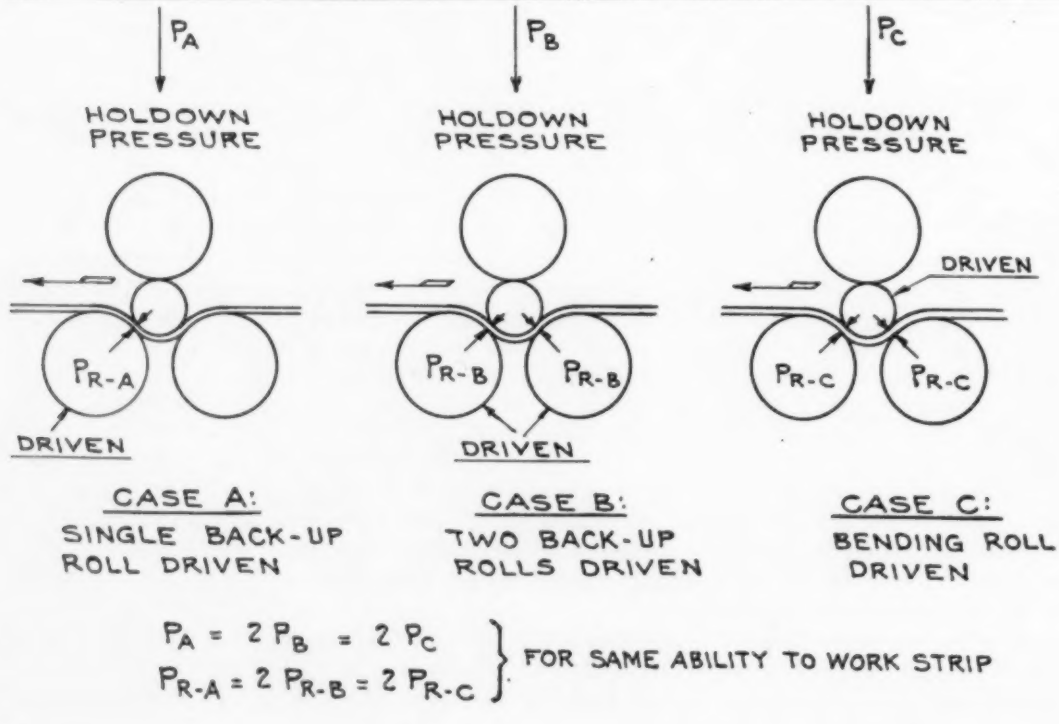


Figure 6 — Sketch shows three possible driving arrangements for nested bending roll sets.

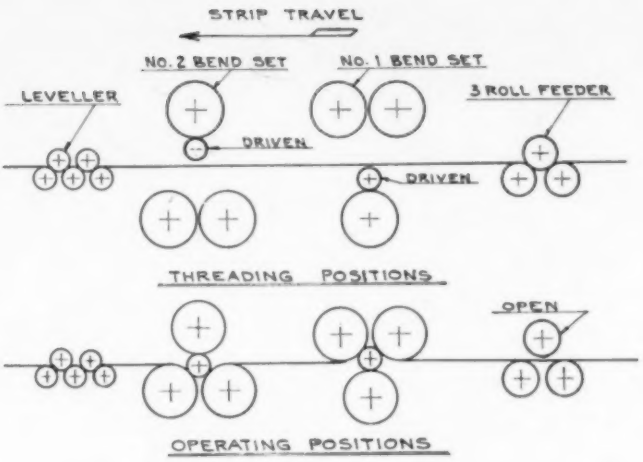


Figure 7 — Sketch shows schematic arrangement of two bend processing scalebreaker.

for the processing scalebreaker to yield as little scalebreaking action as is obtained in present types of scalebreakers, as well as covering the more proper $\frac{100t}{D}$ per cent ranges required for good scalebreaking.

At the entry end of any pickle line, the new processor could be arranged to function as illustrated in Figure 7. In threading position, the two backing rolls of No. 1 bend set and the single backing roll and bending roll of No. 2 bend set would be raised by their respective hydraulic cylinders. Strip would be fed from a suitable coil box or payoff device to the three roll feeder and flattener, which would push the front end of the coil through the open bend sets. The hydraulic cylinders would then close the respective bend sets under a constant pressure, the three roll feeder would be opened, and the strip would then be pushed by the processing scalebreaker to the following unit such as a leveler.

In a continuous pickle line, the scalebreaker could be the first unit after the initial looping pit and should be followed by suitable hot water spray and dip rinsing facilities, and then the usual acid tanks. The advantages of this arrangement are: first, the speed of the scalebreaker and its appreciable power requirements would be limited to only the maximum speed of the pickling zone; second, there would be complete processing of every foot of strip and no repeated threading; third, the significant quantity of broken and loose scale would be washed off by the hot water spray and dip combination, thus reducing acid consumption; and finally, the hot water preheating of the strip would permit the first acid tank to go to work immediately on heated strip.

In addition to the specific advantages just enumerated, the speed up in pickling made possible by the processing scalebreaker gives promise of introducing further direct economies. Reduction in acid immersion time means less acid attack on the base metal areas from which oxide particles have already been removed, and therefore reduced metal loss and further savings in acid are definite probabilities. Figures on these economies must wait until sufficient data has been accumulated on commercial installations.

Other potential applications of the processing scalebreaker, quite independent of its very evident potentialities as a scalebreaker, are worth mentioning. The well-known practice in the automotive industry of temper passing the coils prior to operations leading to the final deep drawing, has pretty generally supplanted the original practice of leveling. This was necessary because the original leveling operations did not provide sufficient cold work, particularly in the outer strip fibres, to prevent a fairly rapid reversion to the yield point elongation, and thus "luder" line formation was encountered. Cold rolling or temper passing could cold work the strip more drastically and a longer storage period was permissible between the cold working and final deep drawing operation. The processing scalebreaker can cold work the outer strip fibres of even thin gages of auto body stock beyond the ½ to 1½ per cent elongation usually taken in the temper rolling operation. It would, therefore, appear desirable to replace the expensive mill operation with the simpler processor operation to achieve the elimination of "luder" line formation. It is also not beyond the realm of possibility that the cold working imparted by the processor could very well be used in many cases in place of the more conventional skin passing operation. These, and similar applications, are potentialities which must be answered of course by future developments.

This paper has attempted to trace the development and background of the processing scalebreaker; has pointed out its engineering principles; has shown its very real advantages when applied to pickle line operation, particularly in terms of savings due to the greater increase in speed of pickling possibilities and also in acid consumption; has pointed out the extreme flexibility and real operating control which is now for the first time available to the operator; and has suggested other possible applications for equipment of this type.

APPENDIX I

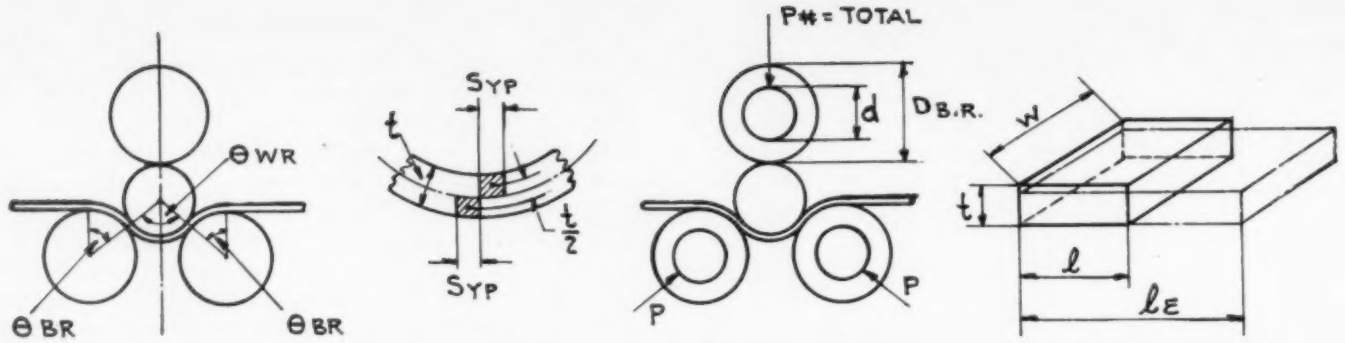
To develop the power requirements for the United Processing Scalebreaker, let us examine the single bend set illustrated by Figure 8-A.

Letting:

θ_{WR} = angle of wrap around bending roll ..... radians
θ_{BR} = angle of wrap around backing rolls ..... radians
S_{yp} = tensile yield point of strip material ..... psi
t = strip thickness ..... in.
W = strip width ..... in.
D_{WR} = diameter of bending roll ..... in.
D_{BR} = diameter of backing rolls ..... in.
T = time ..... min
V = strip velocity ..... fpm
d = bearing diameter — effective ..... in.
μ = bearing coefficient of friction ..... dimensionless
P = total holddown pressure ..... lb
S_{ypave} = average tensile yield point of strip material ..... psi
l = initial length of strip ..... ft
ϵ = strip elongation ..... dimensionless

The total work involved may be separated into the bending work, the friction work and elongation work. These will now be individually considered.

Bending work and energy — Assuming full plastic conditions existing in the strip throughout its flexing passage around the bending and backing rolls, the required internal strip bending moment is illustrated by Figure 8-B and is:



A - BENDING WORK RELATIONSHIP | B - FULL PLASTIC CONDITION | C - BEARING FRICTION WORK RELATIONSHIP | D - ELONGATION WORK RELATIONSHIP

Figure 8 — Sketches show work relationships in new processing scalebreaker.

$$B.M. = S_{yp} \times \frac{t}{2} \times \frac{t}{2} = \frac{S_{yp} \times t^2}{4} \text{ ...lbin./in. width...(1)}$$

$$\text{or, } B.M. = \frac{S_{yp} \times t^2 \times W}{48} \text{ .....lbft — total...(2)}$$

An angle of wrap around the backing rolls corresponding to a given length of arc may be expressed in terms of the bending roll by the following:

$$\theta_{BR} = (\theta_{WR}) \left(\frac{D_{WR}}{D_{BR}}\right) \text{ .....radians (3)}$$

Now the work done by a couple acting through any angle is the product of the couple times the angle in radians. Therefore, the work of flexing the strip around the bending rolls is:

$$W_{WR} = \frac{S_{yp} \times t^2 \times W}{48}(\theta_{WR}) \text{ .....ft-lb (4)}$$

The work of flexing the strip around the two backing rolls is:

$$W_{BR} = \frac{2 \times S_{yp} \times t^2 \times W}{48}(\theta_{BR})$$

$$= \frac{2 \times S_{yp} \times t^2 \times W \times \theta_{WR} \times D_{WR}}{48 \times D_{BR}} \text{ ...ft-lb (5)}$$

Adding (4) and (5), the total work in each bend set is:

$$W_T = \frac{S_{yp} \times t^2 \times W \times \theta_{WR}}{48}\left(1 + 2\frac{D_{WR}}{D_{BR}}\right) \text{ ....ft-lb (6)}$$

Now a given internal of time may be expressed as:

$$T = \frac{D_{WR} \times \theta_{WR}}{24 \times V} \text{ .....min (7)}$$

The bending energy in each bend set is:

$$E_B = \frac{W_T}{T \times 33{,}000}$$

$$= \frac{S_{yp} \times W \times V}{6{,}600{,}000}\left(\frac{100t}{D_{WR}}\right) t \left(1 + 2\frac{D_{WR}}{D_{BR}}\right) \text{...hp (8)}$$

Therefore, for a two bend processing scalebreaker, total bending energy is:

$$E_{TB} = \frac{S_{yp} \times W \times V}{3{,}300{,}000}\left(\frac{100t}{D_{WR}}\right) t \left(1 + 2\frac{D_{WR}}{D_{BR}}\right) \text{..hp}$$

or:

$$\frac{E_{TB}}{W \times \frac{V}{100}} = \frac{S_{yp}}{33{,}000}\left(\frac{100t}{D_{WR}}\right) t \left(1 + 2\frac{D_{WR}}{D_{BR}}\right)$$

hp/in., 100 fpm (9)

Friction work and energy — The resultant radial pressures on the bottom backing rolls of the bending set illustrated by Figure 8-C are dependent on the roll diameter relationships, but for the purposes of this mathematical development, let us assume all backing rolls have the same radial loads.

Total friction work in each bend set is therefore:

$$W_{FR} = (3\mu\ P)\frac{\pi d}{12} \text{ .....ft-lb/rev (10)}$$

Time for one revolution is $\frac{\pi\ D_{BR}}{12\ V}$ .....(min)

For each bend set, the friction energy is:

$$E_{FR} = \frac{(3\mu\ P)\frac{\pi d}{12}}{\frac{\pi\ D_{BR}}{12V}(33{,}000)} = \left(\frac{\mu\ P}{11{,}000}\right)\frac{d}{D_{BR}}(V) \text{ hp/set (11)}$$

Therefore for a two bend processing scalebreaker, total friction energy is:

$$E_{TFR} = \left(\frac{\mu\ P}{5500}\right)\frac{d}{D_{BR}}(V) \text{ .....hp}$$

$$\text{or: } \frac{E_{TFR}}{W\frac{V}{100}} = \left(\frac{\mu}{55}\right)\frac{P}{W}\left(\frac{d}{D_{BR}}\right) \text{...hp/in., 100 fpm (12)}$$

Elongation work and energy — Since the permanent elongation which takes place during the processing operation is small percentagewise, close approximations may be made based on Figure 8-D.

Total force during elongation =

$S_{yp\ ave} \times W \times t$ ..... lb (13)

Distance traveled by force = $(\epsilon - 1)\ l$ ..... ft (14)

Total elongation work in a two bend operation is:

$W_{TEL} = S_{yp\ ave} \times W \times t \times (\epsilon - 1)\ l$ ..... ft-lb (15)

Therefore for a two bend processing scalebreaker, total elongation energy, with time element equal to $\frac{l}{V}$, is:

$$E_{TEL} = \frac{S_{yp\ ave} \times W \times t \times (\epsilon - 1)\ l}{\frac{l}{V} \times 33{,}000}$$

$$= \frac{S_{yp\ ave} \times W \times t \times (\epsilon - 1)\ V}{33{,}000} \text{ ..... hp}$$

$$\text{or, } \frac{E_{TEL}}{W \times \frac{V}{100}} = \frac{S_{yp\ ave} \times t \times (\epsilon - 1)}{330} \text{ hp/in.100 fpm (16)}$$

The grand total energy in a two bend processing scalebreaker is:

E_T = bending energy + friction energy + elongation energy

or, $E_T = E_{TB}$ (equ. No. 9) + E_{TFR} (equ. No. 12) + E_{TEL} (equ. No. 16) ..... (17)

These results are on a net basis and proper efficiency allowances must be made to determine suitable input power requirements.

DISCUSSION

PRESENTED BY

EARL R. MUDDIMAN, Chief Design Engineer, Construction Engineering Bureau, United States Steel Co., Pittsburgh, Pa.

J. I. GREENBERGER, Research and Development Engineer, United Engineering and Foundry Co., Pittsburgh, Pa.

FRED SCHEFE, Flat Products Engineer, United States Steel Co., Pittsburgh, Pa.

JOHN N. BERGER, President, Berger Engineering Co., Pittsburgh, Pa.

Earl R. Muddiman: One question is whether there is enough pressure between those rolls to give semi-temper rolling, in addition to the bending?

J. I. Greenberger: Actually the pressures involved in this scalebreaker are only the pressures required to make the strip flex properly around the bending roll. In actual operation, and we know this both from theoretical and practical experiments, these pressures are less than 1000 or 1200 lb per in. of width of strip. Compare that approximately 1000 lb per in. of strip or less with the normal 40,000 or 50,000 lb per in. of width which are encountered in the conventional rolling operation. That is why the present practice in stainless cold rolling is really so detrimental. It does break the scale, in the Type 430 stainless steel, but it also does roll in a very considerable portion of that scale.

Fred Schefe: Have any experiments been made with light gage cold reduced sheet and tin plate products, such as: 0.040 down, 0.010, 0.025 and so on?

J. I. Greenberger: Gages of 0.040 are very definitely possible. You can take about a 3 per cent strain with 0.040, and the thickness of 0.040 divided by the diameter of the roll should equal 3 per cent, which would mean a roll diameter of about 1¼-1½ in. to do this job. Gages around 0.025 or higher are very practical potentialities, and it is up to you operating people to take the step forward to try it, because it should work. It does work theoretically and will work practically.

The very thin gages, however, when you get down to 0.010, the t over D times 100 equalling, say 3 per cent means the diameter of the roll becomes prohibitively small, so it has gone beyond the range of practicality.

John N. Berger: Are there any scalebreakers of this nature on order right now?

J. I. Greenberger: Yes, we are building one and designing a wide one. We have really two of them going through right now.

John N. Berger: For what widths of strip?

J. I. Greenberger: One is for 12 in. wide and the other is for 42 in. wide strip.

John W. Berger: Do you consider the leveller at the exit end of the line as part of the scalebreaker in your set-up?

J. I. Greenberger: The leveller is only necessary where extreme flatness of strip is essential to the remainder of the processing operation.

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ADJUSTABLE VOLTAGE DRIVES FOR ORE HANDLING

By C. B. RISLER
Industry Engineer
Westinghouse Electric Corp.
East Pittsburgh, Pa.

. . . . adjustable voltage drives have many advantages which result in economical operation . . . . in addition, reliability and low maintenance are outstanding features . . . .

▲ RECENT developments in the art of alternating current control, particularly in the field of crane hoist equipment, may lead the casual observer to believe that the use of direct current drives in material handling equipment is something of the past. This is far from the true picture. Over the past several years, three major manufacturers of electrical equipment have introduced new controllers for constant potential direct current hoist drives as well as new lines of contactors and control accessory devices. Also there have been many recent advances in the application of adjustable voltage drives for bulk handling equipment. It is to the latter that our attention will be directed tonight.

The use of adjustable voltage equipment is nothing new to the steel mill industry. It has been used for years on such drives as rolling mills, blooming mills and pickling lines. However, there are particular requirements associated with each individual piece of machinery to be driven. These requirements feature certain significant advantages of the adjustable voltage system for those particular operations. The author shall point out those features which are brought into focus when these drives are applied to bulk handling equipment.

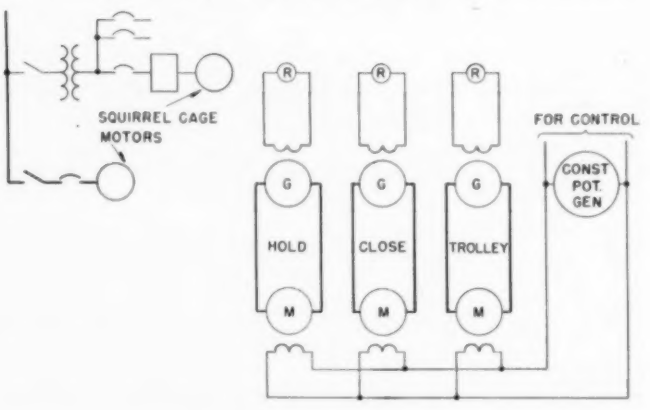
Such bulk handling devices as ore bridges, man trolley unloading towers, some rope trolley unloading towers and the like are logically and almost traditionally driven by direct current in contrast to alternating current. Mill motors with their characteristics of rugged construction, low inertia, standardized design features and interchangeability constitute the primary driving units. When a constant potential system is employed, sturdier control equipment and the better performance characteristics have been available with d-c. This too has furthered the use of d-c drives and — together with the many uses of d-c drives in metal processing — led to the establishment of constant potential d-c distribution systems of considerable capacity in most mills.

Recently many industrial plants in this country, steel mills included, have outgrown their available constant potential direct current supply and with the plant expansion taking place, they find a need for additional a-c to d-c converting capacity, if additional constant potential d-c ore bridges or other bulk devices are to be added. Furthermore the development of long ore yards permitting the stocking of greater quantities of ore bring the added problems of distribution of 230 or 550 volt d-c power without excessive losses due to high I^2R or reduced performance due to high voltage drop. This problem can be solved by distributing the electrical energy along the ore yard at 2300 or 4160 volts a-c and the advantages of direct current equipment on the crane can be obtained by converting from a-c to d-c in a motor-generator set located on the bulk handling equipment. This has been done on an ore bridge using constant potential d-c on the entire bridge. However with an individual motor-generator set, the advantages secured by using multiple generators and obtaining the features of an adjustable voltage d-c system should not be overlooked.

SYSTEM

A typical set of electrical equipment would consist of a motor-generator set driven by a squirrel cage type a-c motor and provided with individual generators for the hold, close, and trolley drive motions. See Figure 1.

Figure 1 — The main drives of a typical adjustable voltage system would consist of a motor-generator set driven by a squirrel cage motor and provided with individual generators for the hold, close and trolley drive motors.



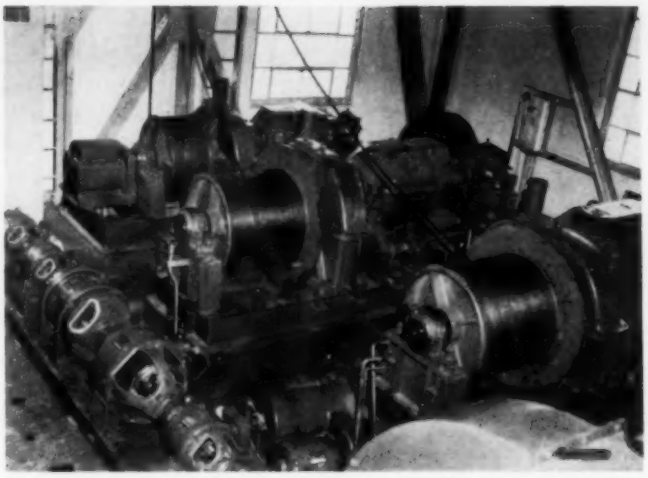


Figure 2 — Rotating regulators for the motor-generator set are shown in the foreground of a machinery room of an unloading tower.

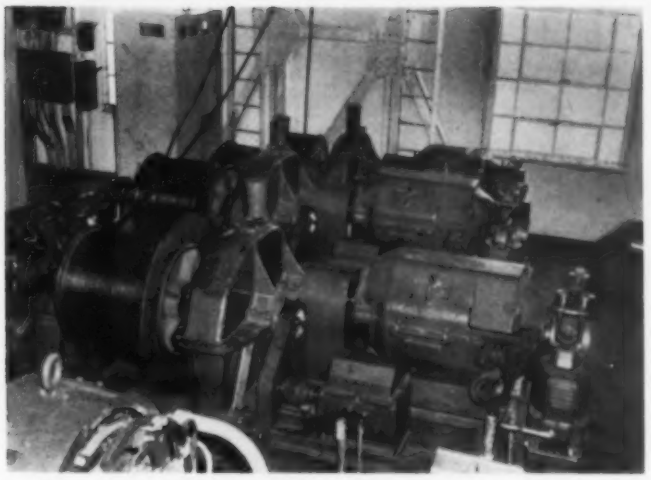


Figure 3 — View shows hold, close and rack drive machinery for unloading tower. Equipment shown is the same as Figure 2.

An additional generator supplies constant potential for solenoid released brakes, motor fields, control circuits and those auxiliary drives such as apron hoist, turntable, and bridge travel drives which do not operate on a cycle basis and do not require the fine control demanded by the main motions.

The driving motors are, as previously stated, of the mill type construction, and would be equipped with spring set shoe brakes released by d-c operated solenoids.

The adjustable voltage system is augmented by a rotating regulator to produce refinement in the peak load requirements, simplification of control equipment and reduced maintenance. There are no contactors interrupting the main power current on a cycle basis since control of the generator field controls the flow of power. Torque limiting features provide assurance against over-stressing the mechanical and structural parts of the towers. Control relays and contactors are kept to a minimum by having the master switches control the fields of the regulators which in turn supply the generator fields and thus control the system performance. These features all contribute to the reliability and reduced maintenance both electrical and mechanical.

The rotating regulator units used to secure these added advantages are of conventional d-c generator construction with multiple field windings familiar to all of you gentlemen. They have been discussed in detail in many papers before the AISE. These units are mounted on a separate motor-generator set and for convenience in mounting in the limited space of machinery houses have been broken up into two such sets, where desirable. A rotating regulator set is shown in the foreground of Figure 2. The picture was taken in the machinery house of an ore unloading tower. In the background are the mill type motors, solenoid brakes and direct connected cam type limit switches.

MOTORS

In applying the drive motors for the hold, close and trolley motions, it is desirable to keep the size of the motors to a minimum to reduce the weight of equipment on the trolley and also the inertia of the driving machinery. The energy spent in accelerating motor, brake and drive machinery accomplishes nothing in moving material or improving the potential value of the material handled. Hence low inertia drives with low accelerating requirements are to be desired. Mill type motors as used with adjustable voltage drives feature low inertia for comparable horsepower and speed.

A further advantage to the use of mill type motors is the fact that they can be operated at considerably higher than their rated voltage of 230-v. On shovel drives they are used with a drooping voltage generator up to 600 v at no load. For bucket type drives where we cannot associate top speed with only light load, we consider operation up to approximately 450 v. Thus, operating shunt wound motors on over-voltage, they run at higher speed. For the same torque and therefore the same motor heating, additional horsepower can be obtained from the same frame size. This permits the use of smaller motors with lower WK^2 and less space and weight required on the trolley equipment. Or stating this fact in the converse, larger bridges and therefore more bulk handling capacity can be obtained with the present size of standardized mill motors. Bridges of 17 to 20-ton capacity are now common rather than the exception.

Operating the motors at high speed permits brakes of smaller size to be employed than would be required on slower speed shafts. Smaller brakes have wheels of lower inertia with further energy savings on a repetitive cycle.

An example illustrating these points is a rope trolley type coal unloading tower recently negotiated. A conventional two motor a-c drive required two 500-hp motors for hold and close, each with a WK^2 of 1800 lb-ft^2 compared with frame 618 mill motors with 742 lb-ft^2 if an adjustable voltage drive was used. Adding the brakewheel WK^2 to that of the respective motors, the true comparison of WK^2 associated with the electrical portion of the drive is shown in Table I. Since the energy expended in accelerating is also dependent upon the motor speed, the speeds have also been tabulated. When the kilowatt seconds required for accelerating each type of drive are considered together with the

TABLE I

Comparison of Motor and Brake Inertias and Accelerating Energy Requirements with Different Electrical Drives

	Hold and close drive				
	Hp	Wk^2†	Rpm	Kw sec †	Wt †
A-c	500	2285	875	810	9410
D-c adjustable voltage	250	1227	790	176	9650
D-c constant potential	450	2585	340	138	12350

	*Trolley drive				
	Hp	Wk^2†	Rpm	Kw sec †	Wt †
A-c	250	648	870	225	5720
D-c adjustable voltage	125	233	885	42	5260
D-c constant potential	250	1227	435	93	9650

*Single Motor Rope Trolley.
†Per Motion Including Brake.

weights, the advantage offered by this feature of the adjustable voltage drive is clearly demonstrated. The constant potential d-c drive is included as academic interest, and because of the slow motor speed shows a slightly lesser kilowatt seconds requirement than the adjustable voltage drive for the hold and close motions. This is more than offset by the added weight and size of the 450-hp motors over those of 250-hp rating.

MOTOR-GENERATOR SET

Immediately upon considering an adjustable voltage drive, one thinks of the size, cost, and additional complication of the motor-generator set — in fact of its very existence — as the outstanding handicap. This is a fact which one cannot overlook. It is the cost you pay for fine control. However, these motor-generator sets need not be excessively large. There are many factors which contribute to their modest size.

The d-c mill motors driving the motions are evaluated and applied on a root-mean-square basis with allowance made in applying them for the running and idle time on a typical duty cycle. The generators on the motor-generator set are applied in the same way but the size is further reduced by the effect of continuous ventilation or cooling of the generator due to the fact that they are continuously rotated even while the motors they are driving are idle.

When it comes to applying the a-c motor to the motor-generator set, additional favorable factors enter the picture. The a-c motor load is smaller than might be anticipated on a first analysis.

1. The motor is rotated continuously and receives the effect of continuous cooling just as the generators do.
2. Furthermore there is load diversity inherent with the operation of the several motions of the unloading device. On an unloading tower, for instance, the bucket is first closed, then the close-and-hold motions operate during hoisting, then the trolley is accelerated and runs in the inward direction. Meanwhile the close-and-hold motors have stopped running because the bucket has reached its maximum travel and so forth on through a typical cycle.
3. The torque required by the d-c driving motor during the accelerating period determines the motor current during this phase of the operation. This current is also the generator current and represents the extent of both motor and generator heating. During the accelerating period, the generator voltage builds up from zero to full voltage over a controlled pattern and the required generator shaft torque increases accordingly. The instantaneous a-c driving motor torque required is the summation of these generator shaft torques. In contrast to a constant potential drive in which the power source puts out anywhere from 130 to 180 or 200 per cent energy during the entire accelerating period, the generator shaft torque requirement in this case varies from zero to the maximum accelerating requirement at a considerable saving of power.

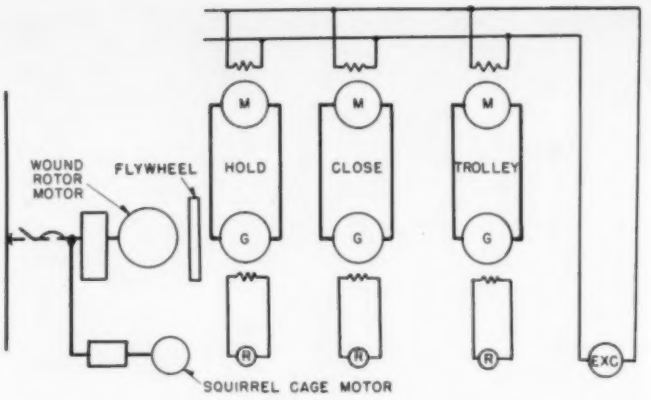


Figure 4 — Simplified schematic of main drives of variable voltage unloading tower.

In other words, as previously pointed out during the accelerating period, the motor-generator set motor requirement for a given drive is only the power actually used. There is no lost energy in resistor heating. This is of great significance on applications with repetitive duty cycles especially when such cycles are of very short

Figure 5 — The motor-generator set supplying the adjustable drives is equipped with a flywheel.

duration — for instance in the neighborhood of 35 to 45 seconds — such as are encountered on unloading towers and on ore bridges during unloading duty, or when reclaiming from a section of the pile near the hopper or transfer car track.

It should be borne in mind that a motor-generator set selected as outlined above will have an a-c motor considerably smaller than the summation of the rated output of all of its associated generators. This produces a set which is applicable for one drive only, and cannot be readily transferred from one application to another without very careful investigation.

The choice of the type of alternating current motor driving the motor-generator set varies with the application. A squirrel cage motor, as shown in Figure 1, can be used for those applications where low first cost is an important factor and where a simple drive is desired. Where power factor correction is a major factor in the cost of power or the utilization of existing distribution facilities, a synchronous motor can be used. The additional cost of the synchronous motor alone is not the only factor which must be considered, however, since the control will be more costly. Also the use of a synchronous motor leads to the desire for stator shift with a corresponding lengthening of the motor-generator set and possible increases in the cost of the steel structure supporting it.

On an application for an unloading tower handling bauxite in Trinidad (Figure 4), the power system was of limited capacity and unable to stand the heavy peak loads associated with simultaneous acceleration of the loaded bucket and the trolley drives. Here the advantages of an adjustable voltage drive in reducing the power requirements during acceleration were a prime factor in influencing the use of this type of drive. Additional cushioning of the peak load was secured by driving the motor-generator set with a wound rotor motor. The motor was supplied with a secondary resistance with permanent slip which permitted the motor to slow down when the peak loads hit the motor-generator set. The set was equipped with a flywheel which, in slowing down, contributed energy to driving the set. Figure 5 shows the motor-generator set installed in the machinery house of the unloading tower. The results secured from this drive have been very gratifying. The principle involved is exactly the same as in a punch press where a high resistance squirrel cage motor is used in conjunction with a large flywheel.

CONTROL

Returning to control features, the three adjustable voltage systems for hold, close and trolley motions are similar in their fundamental arrangement. A simplified schematic of a typical system is shown in Figure 6. Speed control points are provided in each direction with the usual protection against overloads, motor field loss, and loss of a-c power. Regenerative braking is provided for retarding overhauling loads in the hoist controllers and provision is made to limit the torque when the trolley travel drives are plugged.

The rotating regulators on each drive provide speed control by supplying the generator field. Speed is therefore controlled by the master switch located in the

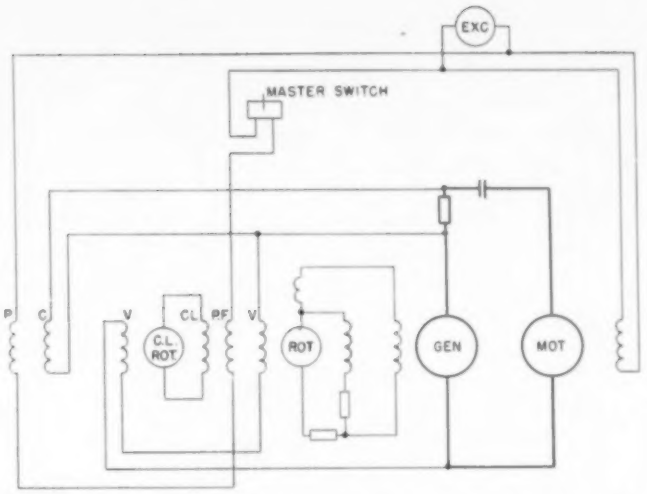


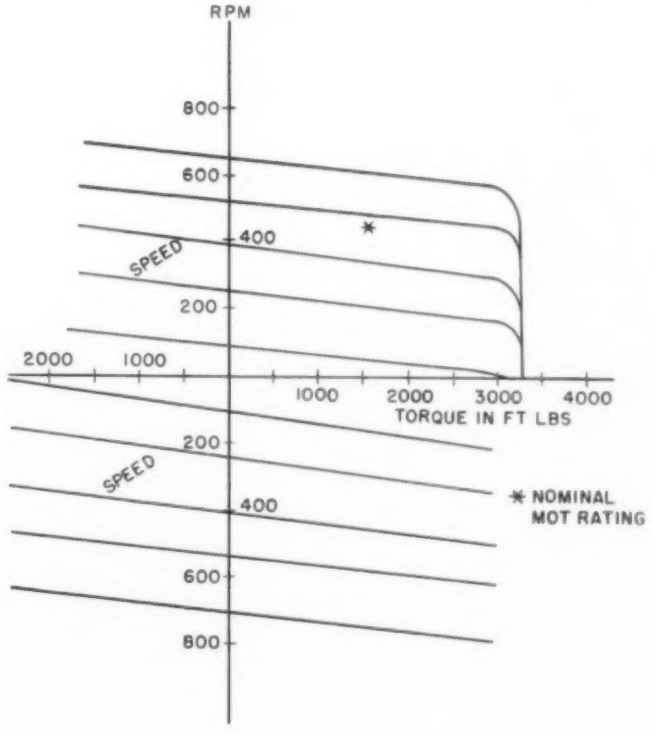
Figure 6 — Simplified schematic diagram of single, adjustable, voltage drive.

pattern field circuit P. Reversal of the motor direction is also obtained by reversing the pattern fields P. The speed regulating features secured by comparing the pattern field P with the voltage field V, operate to provide 8 to 10 per cent regulation in the operating range of the drive.

The torque limiting feature, secured by the current limit field CL on the main rotating regulator supplied by the separate current limit rotating regulator unit, limits the current output of the generators and thus keeps the power peak and shock to the structure at a minimum.

The speed-torque characteristics of the hoist drives with a current limit rotating regulator unit are shown in Figure 7, depicting moderate speed regulation over

Figure 7 — Curve gives speed-torque characteristics of bucket hoist drives with current limit rotating regulators.



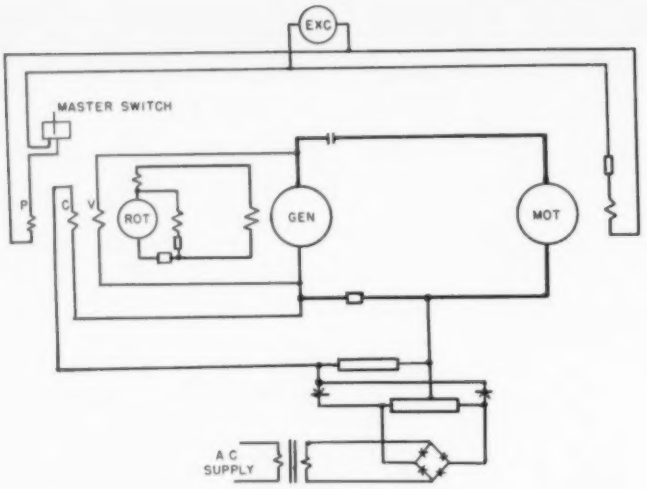


Figure 8 — Simplified schematic diagram of a variable voltage hoist drive.

the operating range and the torque limiting features limiting the maximum torque. This maximum is set at a sufficiently high value to accelerate the full bucket at the desired rate. It will be noted that the two highest operating speed curves are above the rated speed of the motor. This feature is brought about by operating the motors at a higher voltage than rated voltage. This gives higher motor speed and thus secures more horsepower for the same torque. Economy in motor application results.

Figure 8 illustrates an alternative method of securing the torque limiting features which have been employed. It involves the use of a biasing rectox circuit in place of the second or current limit regulating unit. Alternating current is rectified and used to establish a constant or standard d-c potential. The drop of power loop current across a section of resistance is then compared with this standard to control the current limiting action.

The speed torque curves obtained with the biasing rectox system of current limit are shown in Figure 9. The cut off is not as sharp as with the current limit rotating regulator. However, the increase in torque at standstill is gradual through the advancing master switch positions. This is an advantage in some cases.

In the lowering quadrant, the dotted curve for the fifth point lowering indicates the performance setting for the hold motor and a solid curve that for a closed motor. In this manner the load is divided between the two drives in lowering and permits lowering an empty bucket open at high speed. The weight of the bucket is carried by the hold drive and the close drive runs at no load at the same speed. This assures a minimum of tension in the close line.

This method of load division is very acceptable for unloading towers such as the two built for the Trinidad transhipping station of the Alcoa Steamship Company. See Figure 10. There the job to be done is one of hoisting a closed bucket and lowering an empty bucket. Material is lifted from the hold of a small ship or barge and deposited in a hopper from which it is taken by a feeder conveyor onto a transfer or stocking system into storage or to an outbound ocean-going vessel. The arrangement can also be used on coal and ore bridges where loads must be reclaimed from stockpile and loaded into cars calling for lowering loaded buckets and hoisting open ones as well as hoisting closed ones and lowering empty ones.

A further refinement can exist in which one master switch will function to control the closing and opening of the bucket only. This master switch will therefore operate on the close motor drive. A second master switch will operate on both the close-and-hold motors in such a manner as to control the hoisting and lowering of the bucket only. It will be readily seen with the characteristics of our present day bucket such that the load on the close line must be essentially zero if the bucket is to remain open, that the load division between the close-and-hold drives will have to be adjusted to the condition of handling an empty or a loaded bucket. This can be done by a selector switch or by keying the load division to the last operation of the close motion. For instance, if the bucket has just been operated in the close direction, it can be assumed that the load was being dug and when the hoisting master switch is operated, the rotating regulator equipment will operate to provide essentially constant load distribution between the two motors. Should the last operation of the close drive have been in the open direction, the load would be so divided that the weight of the empty bucket would be entirely supported on the hold drive, and the close drive would operate at bucket speed but without applying tension to its line.

Speed-torque characteristics of the trolley drive have about the same features as pointed out for the hoist drive on the previous figure. The free running torque requirements of a trolley drive are, in general, considerably less than the motor rated torque. The problem is mainly one of acceleration and the constant torque accelerating features available become of prime import-

Figure 9 — Curve gives speed-torque characteristics of bucket hoist drive.

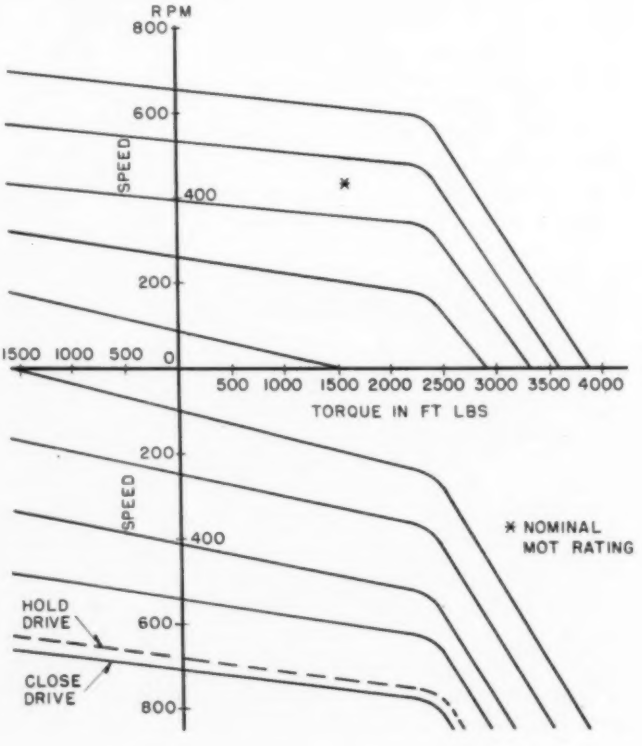


Figure 10 — View shows pier for Alcoa steamship transfer station at Trinidad. Two unloading towers are shown on the far side of the pier and one loading out tower is shown on the near side of the pier.

ance in accelerating the trolley in a minimum of time and with the minimum tendency to develop bucket swing.

LOCATION OF EQUIPMENT

Where adjustable voltage drives are used in rope trolley type of unloading towers, the equipment, both motor-generator set and driving motors, will all be located in the machinery house. The motor-generator set can be located in the rear and serve as part of the designed counter-weighting of the structure. In a man trolley type of unloading tower, the motor-generator set is again located in the machinery house and the rotating regulator sets are also located there. This keeps the electrical equipment on the trolley to a minimum. The master switches located on the trolley control the rotating regulator fields without appreciable variance due to the position of the trolley along the boom. The short distance of trolley travel permits this form of operation.

For ore bridges, the motor-generator set is located on a house located on top of the ore bridge structure. The rotating regulator equipment can be located either in this machinery house or on the trolley, if it is thought the drop in voltage along the collector system will prove deterimental to the performance of the equipment.

It is our belief that with the proper design of the control circuits, that the master switches on the trolley can operate the control fields of the rotating regulator units with the rotating regulator set mounted at the main machinery house.

The approximate weights of the electrical equipment located on the trolley of a 12 ton ore bridge are tabulated in Table II. The use of adjustable voltage drive achieves a reduction of 19,100 lb or 40 per cent in equipment weight. This reduction is reflected in weight of the bare trolley and all supporting structure to effect a greater overall reduction of weights and structural costs. From the standpoint of operating economy, it must be remembered that energy devoted to accelerating trolley and equipment weight is wasted, and developments loading to its reduction warrant serious attention.

TABLE II

Weight of Electrical Equipment Located on Trolley

	Constant potential drive, lb	Adjustable voltage drive, lb
Motors	27,170	20,970
Brakes	5,755	4,475
Control panels	4,810	1,350
Resistors	8,170	940
Accessories	1,530	600
Total	47,435	28,335

CONCLUSION

Thus in applying the electrical equipment to bulk handling machinery, this paper has pointed out features available with an adjustable voltage drive which are not available with the other drive systems. Contributing features exist on all of the pieces of apparatus from the mill motors driving the machinery back through the generators and a-c motors to inherent economies in the power distribution system and power consumption. In summary these features which warrant consideration of adjustable voltage drives for bulk handling systems are:

1. Smaller d-c driving motors.
2. Economies in power distribution.
3. Reduction of peak power requirements.
4. Reduced overall power consumption.
5. Improved power factor.
6. Reduced weight of equipment on trolley resulting in overall reduction of structural requirements.
7. Simplified operating procedure — master switches control one function only.
8. Reduced stress on structural numbers due to limitation of peak torque.

The above advantages and features are secured in addition to the advantages of high reliability and low maintenance.

DISCUSSION

PRESENTED BY

JOHN SOWERS, JR., Superintendent of Construction, Bethlehem Steel Co., Lackawanna, N. Y.

C. B. RISLER, Industry Engineer, Westinghouse Electric Corp., E. Pittsburgh, Pa.

E. L. BLANKENBEKER, Heyl & Patterson, Pittsburgh, Pa.

E. A. HORSLEY, Provincial Engineering, Niagara Falls, Ontario, Canada

P. B. MANSFIELD, Electric Power Engineer, Maintenance Department, Republic Steel Corp., Buffalo, N. Y.

SAMUEL RIFKIN, General Electric Co., Schenectady, N. Y.

John Sowers: Your scheme is very admirable in many points. The only practical question in my mind is, how do you accomplish your collector feed system for handling either 2200 or 4160 v, for your motor-generator sets, and do it in a safe manner, on an ore bridge or any loading deck?

C. B. Risler: I can refer you to the fact that it has been done for a good many years up in the Duluth-Superior area in the upper Great Lakes where the coal storage bridges are operated from a high voltage, a-c pickup system. A coal handling bridge is also installed in Follansbee, West Virginia, where this type of distribution with a-c, d-c motor-generator set in operation on the coal deck. The problems of distributing the a-c system to the bridge are considerable. It is a matter of getting adequate installation, getting equipment out of the way of personnel. It has been satisfactorily handled in those locations. I think the best way to actually work out a system would be to consult some of those people. Where there is a "high line" or elevated track at one end of the bridge, the high voltage distribution system can be mounted on this.

E. L. Blankenbeker: We are very much interested in the type of drives described, and feel they should be given more consideration in making future studies of bridges, particularly where long runways are involved, and conversion equipment has to be considered. We have built drives using adjustable voltage for bucket operation and also conveyor belts, and they are working very satisfactorily. In connection with the bridge travel drive, Mr. Risler chose to describe the use of constant potential for the bridge drive. I would like to suggest that consideration be given to making this an adjustable voltage drive also, and use it non-simultaneously with the bucket hoist, by transferring the two hoist generators to the bridge drive motors. The same control equipment that is provided for the bucket hoist would be used for bridge travel. This is something that might have merit, in that you eliminate rheostatic control for bridge drive which required considerable maintenance and is costly. Another thing that might be discussed is the question of whether or not the main line power contactors that are shown in some of the circuits between the motor and generator are always necessary. We do not know for sure. We lean on the electrical equipment builders for recommendations of this nature. In my opinion they would not be necessary where you have a rope driven trolley where the circuits are short. Where motors and generators are separated by sliding contacts, a means of disconnection available in the trolley indicates the need for main contactors. An amplification of the added ratings that are obtainable for mill motors when run at higher speeds and higher voltages, is the more efficient cooling at higher speeds used to increase the rms rating of the motor?

C. B. Risler: I will try to take up these points which Mr. Blankenbeker has raised, in the order in which he has raised them. Driving the bridge with an adjustable voltage drive is a very fine suggestion. It will eliminate the requirement of additional power in the constant potential d-c generator which must be supplied on the motor-generator set. With the hold and close generators serving a dual purpose, the only hitch is getting the user to limit his travel operation of the bridge drive to such times as he will not want the hold and close drives. In general this would not be a restrictive limitation on a stocking and reclaiming bridge, but could be a severe handicap on an unloading tower or bridge. You can put in a transfer switch and transfer your circuits so that hoisting generators can be used to drive each end of the bridge respectively. It will not only reduce the size of the constant potential generator, but will also reduce by several, the number of collectors required between the trolley and main structure.

On the matter of power contactors in the main connections between motors and generators for any one of these drives that contact is a necessity if you are going to use emergency dynamic braking. If you want to break up the circuit from the motor to generator and establish a closed circuit immediately around the motor with a dynamic breaking resistor, a contactor is needed for the main power line. That contactor does not operate on a cycle basis. It operates only once or twice in the course of a day or when the operator presses the emergency stop button. I thoroughly agree with the use of such contactors for ore bridges where you have a man riding trolley remote from the generator set. Where you have a rope trolley, the man is in a stationary cab, you have a light trolley moving in-and-out and the motor and generator are in the same machinery house, then it is reasonable to eliminate the dynamic breaking feature and the line contactors.

Regarding the question of operating motors at higher speeds and therefore obtaining more rms or thermal capacity out of the machines, I think that has to be considered on the basis of motor construction or motor enclosure. A totally enclosed motor eliminates heat by radiation and when operated at a higher speed has no more radiation than when operated at a rated speed. Therefore while there is an increase in output horsepower due to the operation, at higher speeds there is no increased rms horsepower due to the increased cooling effect. On a self-ventilated machine, additional cooling is secured by a faster operation of the motor and additional rms capacity is available from a motor under such operating conditions. A force-ventilated motor is a subject of study at the present time to determine just to what effect increased cooling can be obtained. Bear in mind in a forced ventilated machine there is a lot of air through the available space in the machine when operated at its regular voltage and when operated at a higher voltage, little increased cooling would be secured.

E. A. Horsley: I would like to know what provisions are made to eliminate the effect of residual magnetism of the generators in circulating current when the controllers are off. A diagram showed the master switch controlling the fields directly. I am wondering if that is direct, actually, or whether there are contactors to handle the inductive circuits involved.

C. B. Risler: Regarding your last question, the master switches can be used directly in these fields you refer to. The steel mill type of master switch can handle the rotating regulator pattern field circuit. Regarding the circulating currents, the rotating regulating equipment operating with the master switch will operate to reduced circulating currents, and if further necessary a killer field can be provided in the generator to take care of that particular situation. There would be no tendency for drifting on drives, such as hold and close,

where brakes would be set. It would be a matter of reducing the current because it is undesirable for the motor and generator.

P. B. Mansfield: The paper showed an ingenious circuit arrangement from the standpoint of design engineering. However, from the standpoint of maintenance, I would like to ask his opinion on the relative cost of maintaining such equipment, as compared with d-c constant potential control on ore bridges. In this circuit we have twelve rotating machines with associated multiplicity of small control devices as compared to two or three motors with relatively simple circuits and devices. In our experience on ore bridges with the general conditions of dirt and vibration, I am just a bit fearful of the maintenance cost of all these pieces of equipment.

C. B. Risler: There have been no figures developed. There have been no adjustable voltage ore bridges or unloading towers of the type shown in the latter stages of this paper operating long enough to compile such figures. I would say that in contrast to your problem of maintaining the multiplicity of rotating units which you mentioned, there exists the problem of maintaining constant potential control with a multiplicity of main line large power contactors which are subject to burning and very frequent operation with each cycle. These contactors are large pieces of equipment with appreciable mass operating in and out each time the contactor is engaged, whereas the rotating equipment added in going to an adjustable voltage drive is continuously rotating and easily maintained with scheduled attention. As regards conditions of dirt, there have been provisions made in these large machinery houses for filtering the air that goes in, to remove the dirt from it, and essentially have a semi-airconditioned house. That would to a large degree alleviate that problem. I do not think that the overall cost of maintenance would be any greater, in fact I look for it to be less.

Samuel Rifkin: The use of adjustable voltage drives on material handling apparatus is far from new. That system has been used successfully for many years on skip hoists, car dumpers, etc. Nevertheless, there has been considerable reluctance on the part of ultimate users to investigate adjustable voltage equipment — primarily for the very reason brought out by the last question — the fear of excessive maintenance expense on the rotating equipment. However, experience with adjustable voltage strip mills has clearly shown that rotating equipment maintenance is not too serious a problem. The benefits that are obtainable in reduced mechanical and control equipment maintenance more than offset the cost of keeping the motor-generator set in good operating condition.

Adjustable-voltage drives have been in use on unloading towers since at least 1924. In that year, a New York public utility system installed an adjustable-voltage operated coal unloading tower similar to an a-c operated tower that had been installed the previous year. Both towers were geared for the same guaranteed capacity and the same high lift. After the operators had become thoroughly familiar with handling the controls, a check was made on power consumption. The a-c tower required 1.21 kwhr per ton, as compared with 0.59 kwhr per ton for the adjustable-voltage tower.

Those data were taken with both towers operating continuously. Naturally, consideration should also be given to the fact that the motor-generator set continues to draw power during clean-up operations, barge movements, and other short intervals of time when the operator is at rest. In order to include the "running light" losses in the power consumption data, an additional test was made with the adjustable-voltage equipment operating 80 per cent of the time and the motor-generator set running unloaded for the remaining 20 per cent. The power consumption then increased from 0.59 to 0.62 kwhr per ton, but that was still only very little more than one-half of the 1.21 kwhr per ton required for the a-c tower. In addition, the kva line peaks required by the adjustable-voltage tower were only 75 per cent of the peaks required by the a-c tower. The explanation is very simple — the adjustable-voltage drive eliminates all of the power losses in resistors and utilizes low-inertia d-c mill motors that require less power for acceleration and deceleration of the motor rotors. Obviously, it is worthwhile to investigate power consumption and maximum kva demand when a new large capacity installation is being considered.

After one year of continuous service, maintenance on the adjustable-voltage equipment had consisted of replacing two worn tips, cleaning the remaining tips, and wiping the commutators. Of course, a one-year interval is a relatively short time for analyzing maintenance. However, a recent check with the power company has shown that the mechanical and electrical maintenance for the adjustable-voltage tower has been almost negligible compared with that for the a-c tower, and twenty-six years of operation is certainly adequate time for a conclusive comparison.

The adjustable-voltage drive also has other advantages, such as slow landing speeds and positioning accuracy. Furthermore, the mechanical system is not subjected to sudden shock load. Instead, the time constant of the generator field results in relatively gradual torque changes, which is much easier on the gears and cables.

Table III gives a cost and space comparison of d-c rheostatic equipment with adjustable voltage equipment.

TABLE III

	D-c rheostatic	Adjustable voltage
Space required on man-trolley for control for bucket hoist and trolley drives, cu ft	425	200
Weight of control installed on man-trolley for bucket hoist and trolley drives, lb	13,500	4000
Installed cost per hp (in dollars) of all electric equipment on unloader	105	145
Installed cost per kw (in dollars) of substation for unloader	100	20
Total installed cost per hp of electric equipment for complete installation	185	160

Installed cost data are based upon prices as of March, 1949, and they assume an incoming power supply of not less than 15 kv for a total substation capacity of 1500 or 3000 kva.

Supervisory

. . . . the foreman is part of the management team and should be treated as such . . . .

▲ IT IS the purpose of this paper to point out why supervisory development is urgently and continuously needed. I will also describe some of the methods that have proved to be most successful in industry's attempts to improve supervision.

As president of The National Foremen's Institute I have been concerned with the training of foremen and other supervisors for well over thirty years. This does not mean that I presume to know all the answers. It does mean, however, that I have acquired some basic convictions or, if you like, prejudices on the subject of supervisory development.

I believe, for instance, that the manner in which foremen attend to their duties largely determines the number of problems with respect to both production and labor. More than that, the foremen's functioning, or mal-functioning, determines the intensity of those problems. I am not saying this because of a desire to propagandize the foreman's importance. I merely express what I believe to be a fact. In other words, and regardless of personal opinion, foremen cannot help but hold a position of extreme importance in industrial operations and industrial relations.

This is obvious enough when we think of all those aspects of the foreman's job that require technical knowledge and competence. Every foreman is or has been selected for his position because he knows, or is presumed to know, what the work he directs and supervises is all about. And the greater his familiarity with work processes, tools and machines, the greater his ability to make the kind of intelligent decisions that are at the very root of efficiency and economy. As to production in the technical sense, I do not think that anyone would wish to dispute the importance of the foreman's job.

But technical knowledge is *not* in itself sufficient. It is *not* the foreman's job to get out production. It is his job to get other people to get out production. In other words, he must cause other people to do the things he wants done, how he wants them done, where, in what quantity and quality he wants them done. This requires the ability to get along with people and the skill to influence their thoughts, words and deeds.

Most of the foreman's time and energy is spent in contacts with the men or women under his supervision, with members of staff department and with members of higher management. It should be evident, therefore, that how the foreman conducts himself in those relationships is at least as important as his technical talent or knowledge.

This may seem a commonplace statement to make. But the realization is by no means general that the foreman's relations with personnel of all types and ranks call for qualifications which are as essential as his technical ability. I am referring to his qualifications as a teacher and giver of information, as a counselor and conciliator, as the "boss" or personification of the company, and as a friend and leader of his men.

I do *not* contend, of course, that foremen have all these qualifications — as I would *not* claim that they have all the technical skill and knowledge required of them. Very few of us, no matter what position we may hold, have all the qualifications we should have. I only want to make sure that there is no misunderstanding as to what is involved in foremanship.

The foreman's job is a big job. How big a job it is we most readily understand when, instead of looking at its usual accomplishments, we look at its failures — when we look at the tensions and irritations that beset the relations of foremen to workers and staff experts; when we look at the misunderstandings and concealments that characterize a great many contacts of foremen with superintendents and other members of higher management; when we look at their mistakes in production, their opposition to instructions and orders, their neglect of responsibilities and duties. As a matter of fact, if I were to judge our present-day foremen by the complaints of many executives with whom I talk, the verdict would be one of severe criticism.

This criticism points to real faults. I am not at all convinced, however, that it is the foreman who is to blame. As I have said, his is a big job, and I am sometimes under the impression that it is getting bigger all the time. This trend has some obvious as well as some obscure reasons.

Right now, for instance, with the requirements of war production gradually increasing, a serious shortage of both skilled and unskilled labor appears to be inevitable. On a nation-wide basis, unemployment is already down to what seems to be an irreducible minimum. That minimum is composed of transients from one job to another, misfits, persons laid off for seasonal or technological reasons, and similar small groups of people. This means, as it always does when jobs are plentiful, that labor turnover is rising. Compared with half a year ago, voluntary quits have already doubled and tripled in many communities.

But statistical terminology fails to convey the headaches that accompany loss of personnel. It is the foreman who suffers those headaches. He is virtually sure that for every experienced man he loses, he may have to employ someone who *not* only does not know his way around, but who may never have worked in industry before.

This prospect is suggested by our over-all manpower situation. Specialists in this field estimate that our working and fighting force totals about 70,000,000 men and women. When the Korean war began, about 64,000,000 were already on civilian, government and army payrolls. This leaves about 6,000,000 in the manpower reserve — not 20,000,000 as in 1940. What is more, the 6,000,000 reserve is largely composed of boys

Development

By A. C. CROFT

President

National Foremen's Institute, Inc.

New London, Conn.

and girls without job experience, of college students who should continue with their academic training, and of older people who will only stand up under the physical requirements of relatively few jobs.

There is no doubt, then, that job training, the transformation of inexperienced into skilled people, is again becoming of A-1 importance throughout industry. Foremen and other supervisors will have to assume most of the responsibilities of the selection, placement and training involved. How many of them are qualified to do that? Who has prepared them?

There is another obvious reason for the foreman's increasing responsibilities. From the few manpower figures given you, and in view of what are expected to be snow-balling claims on production from now on, it is perfectly evident that we will have to tap the manpower reserve that lies in longer working hours. A switch from 40 to 48 hours would equal a 20 per cent increase in employment and output. As you know, however, it would do that only if the fatigue factor were as negligible in the case of people as it is in the case of machines. That is not so, of course. And therein lies the source of a great variety of production impediments — spoilage, breakdowns, accidents, absenteeism, violations of discipline.

These factors are, of course, of greatest concern to top management. But it is the foreman who is immediately affected and who has to deal with them directly. Let us ask again: Is he qualified to do that? Who has prepared him?

Real and urgent as these problems are or may become — and let me say at this point that I know as little about the prospects for an all-out war production effort as the next fellow — I am inclined to think that the demands made on foremen are increasing all the time. It is true that the new demands and responsibilities are rarely formulated. In most cases they are implied in the conditions under which foremen have to work and operate. I am going to mention just a few of them.

The range of technical innovations and improvements in procedures that have been made in almost all phases of production within the last years is great. I am not referring so much to entirely new industries, such as television and some chemicals, as to the new materials, tools, machines, work processes and control systems that have been introduced everywhere. Much of this technical progress has not yet been digested in terms of the skills and work habits of workers and foremen, nor in terms of the foreman's ability to watch, analyze and report.

Many foremen have yet to catch up with the changes that have taken place in the work they are supposed to supervise or to do themselves. But although, in this area of technical competence, the need for methodical instruction and training of foremen is apparent to all, it is suprising to note how little is being done to meet that need.

Here is another problem. Within the last ten years or so, employers have tried one approach after another to solve the question of who is boss on the work floor. Is it the foreman, or is he merely a glorified errand boy and mouthpiece for someone else? It is highly significant to me that, no matter what the attitude of management may be on this point, the men themselves seem to have no doublt on the subject. As far as they are concerned, and regardless of whether anybody agrees with them or not, it is the foreman who is boss. He is not only part of management to them, he *is* management.

This can hard'y be otherwise. Workers may know that the foreman who supervises them has little or nothing to do with setting policy or making basic decisions. From where they stand, however, it is the foreman who is responsible for final execution — that part of execution that affects them. Even if they consider the foreman as the connecting link between themselves and the executives — an attitude which comes closest to the real situation — they still tend to expect of the foreman that he exercise the judgment of management and all the prerogatives of management that have any bearing on them, their work or their relations with the company.

Let me dwell on this point a little longer. If, as there is ample reason for believing, the foreman is management from the workers' point of view, it is inevitable that a company is judged by the foremen it keeps. No board of directors can change that fact, nor can the works manager or the superintendent change it.

When a foreman reprimands, lays off, transfers or changes the work assignment of a man, the worker interprets these acts of the foreman as being those of the company.

Whenever a foreman does not know the answer to a problem or question; or when he delays in making decisions or goes back on a promise — it is the company that is criticized. Furthermore, whenever a foreman shows incompetence or ignorance to the worker, it is the company that is at fault.

Maybe some think that I am exaggerating. If so, please give the matter a second thought. Is it not true that we form our impressions of an organization from the type of person who represents it? And are we not particularly apt to do that when we feel imposed upon or have something to criticize?

An insolent waiter makes us irritated with the restaurant that employs him. Poor service in a dining car makes us swear at the railroad. An inattentive sales clerk creates an unfavorable reaction against the store that gave her the job. It is always "THEY" who are responsible. And "THEY," to come back to the workers, is management, is "the company."

Let a foreman be high-handed, impatient, fumbling, thoughtless or ill-informed, the worker will always

blame the company for the displeasure or hurt he suffers at the hand of the foreman. If this situation could be changed, probably 90 per cent of all arbitration cases would immediately disappear, and so would a great many disputes that finally end up in strikes and walk-outs.

It is equally important to recognize that foremen are very well aware of the fact that in the minds of the workers they are identified with management. I am not saying that many foremen are able to articulate that awareness. And neither do I suggest that foremen are overly introspective in regard to the mistakes and blunders they commit. From hundreds of personal contacts I have had over the years with foremen, I would make the point, however, that most of the criticism they level at top management — and there is a lot of such criticism — reflects the foreman's own misgivings about his qualifications as a management representative. Allow me to voice some of their criticism — and I quote actual statements given by foremen in response to a questionnaire:

1. "I have two hundred people under me. How can anybody expect me to do a good job? I would have to be ten guys to do all the things I am supposed to do."
2. "Three of my best men take home more money than I do. They and everyone else know that. I am a sucker in their opinion. The company just isn't interested in giving us foremen the financial status we deserve and should have."
3. "Too many organizations, at least among those I know of, don't treat their foremen as management men. They don't hold out the financial reward and incentive that foremen must have in order to keep doing a good job."
4. "We're getting soft-soaped all the time. But what about some honest-to-God information? I don't know about other companies, but I do know that our company treats us foremen as if (1) we were responsible for everything, and (2) not worth the money any union member is worth."
5. "Our boss knows *that* the union stewards know more about what is going on than we do. But he hasn't yet seen fit to explain the contract to us and give us his interpretations."
6. "The men go to their steward with their troubles. But to whom do we go? That's the real weak spot in industry today. It should be so easy for the superintendent to establish relations of mutual confidence with the foremen. But nothing like that is done."
7. "When it comes to a showdown, if only a little one, it is rare that the foreman is backed up by higher management. On the contrary, we usually get it in the neck, first from the union and then from the boss."

The note common to all these statements seems to be one of angry embarrassment. The foremen who submitted these frank views are obviously quite cognizant of this or that deficiency in their position. I am saying this because none of this criticism would make sense if those who advanced it did not feel that they were management representatives; and that their earnings, their authority, or their knowledge did not come up to the level implied in their position.

What I find significant about these communications is not the criticism they express — for there is usually another side to every criticism. The real significant part of these communications lies in what they imply. And that is the conviction that foremen should be recognized and treated as part of management. The time for insincere lip-service has passed.

What is industry doing about this problem? Let me say, first, that the problem is being more and more recognized. Happily, ever since the unionization of foremen has ceased to be a serious threat, there has been less of the mere protestation of management goodwill toward foremen. We have been hearing fewer and fewer speeches on the subject that "foremen are part of management." In other words, instead of protesting the obvious, industry has increasingly become concerned with attaching real significance to the obvious.

How can we translate the description "part of management" into meaningful reality? This seems to be the attitude which progressive executives are taking with respect to the foreman's place in the organization. I am glad that change of attitude has come about in such a short time.

But there has been much more than just a change in attitude. Many programs have been introduced — many of them not only extensive but novel in their concepts — which aim at giving the foreman the professional training and assistance he needs in order that he might do his job more efficiently.

The job of the foreman involves, mainly, three things:

1. The supervision of the department of which he is in charge; that is to say, control of the activities of his department and the meshing of his department's activities with those of related departments.
2. The human relations aspects of his job as leader, instructor, guide, counselor and friend of his workers.
3. The status he holds within the management structure.

Let me give you a few examples of supervisory development practices that are now being followed in various companies.

As to the things a foreman must know and do in order to discharge his duties efficiently, it has occurred to many executives that telling and writing him is not enough. Giving orders and instructions is a one-way method of communication. That type of communication is only adequate when it is desired to give a message of some kind. But isn't there more than a message involved when you want to rearrange a work schedule, or when you want to have any one of the thousand-and-one things done that only your foreman can do or can arrange to have done? He is involved, his men are involved, the work he and they are doing at the time is involved — and so may be the foremen and men of other departments.

You can still give your message, of course, and you can give it in the form of as strict an order as you wish. But because you do not know — because you cannot possibly know — what is going on at the receiving end of that order, the chances are that your message will not quite hit the mark. How many orders have *never* been executed, or have only in part been executed, or carried out when it was too late, or executed against what would

have been your better judgment if you had known the things you did not know at the time you gave your order? In short, you know from your own experience that one-way communication is not a good way to get things done.

It is this realization which has led to the formulation and dissemination of orders and instructions by way of give-and-take discussion. This is accomplished by regular daily or weekly conferences of members of the supervisory staff of the division or divisions that are involved in the subject under discussion.

I am restricting my remarks to the general idea of two-way, or up-*and*-down, communication. In practice, many systems of interlocking conferences, and series of conferences, have been developed to include everybody from the president to the gang leaders and men themselves. But whatever the particular method, the general idea is always the same. It is that all who will be affected by an action to be taken, or should know of a consideration to be kept in mind, participate in formulating that action or in defining that consideration. That is the gist of two-way communication as a means of improving the foreman's competence and know-how.

Let me move on to the human relations aspect of the foreman's job. All of us, I am sure, are in favor of good human relations. But what do we mean by that term? What do we expect the foreman to do about his human relations? And how do we expect him to do it? It is easy to define good law, good medicine, good biology and good engineering. But what is good human relations? You may say that is a silly question to ask because everyone knows that good human relations lies in following the golden rule. But did you ever *find* anybody who knows how to apply that rule? Do you, individually, apply it?

It would help a great deal if we would acknowledge to ourselves and in public that our knowledge of good human relations is still in its infancy. What we do not know on this subject may fill and, let us hope, will fill entire libraries of future generations. Meanwhile, we have a job to do. It is the job of finding out of what the bad human relations consist from which we are suffering today. Once we know what we are doing wrong, and how we are doing it wrong, we will learn some useful lesson for doing things right.

This is the thought that underlies two methods of supervisory development which enjoy increasing popularity. I am referring to the role-playing sessions of foremen, in which they act out, or repeat by acting out, the conflicts and controversies which they have had with their men or their superiors. And I am also thinking of the situation-analysis sessions which foremen in some companies conduct with the help of outside specialists.

It is the purpose of both these types of sessions to analyze behavior — to see how emotional reactions come about and to realize how one's behavior is likely to affect and influence others. You might say that this kind of work is trying to do something about the old injunction, "Know Thyself."

The general idea is that a person has first to realize some of his own emotional peculiarities and needs before he can begin to understand the actions and reaction of other people. Once he has acquired that understanding, he will better be able to control his own behavior and pursue his objective without making enemies or setting up unnecessary barriers to agreement. By learning how to avoid the words, gestures and acts that arouse hostility or fear in others the foreman learns how to establish relations of mutual respect, confidence and consideration.

And now a word regarding the status foremen hold within the management structure. As some of you will be able to verify, definite efforts are being made to include foremen firmly within the ranks of management.

Since statistics of foremen salaries are lacking, it is impossible to say just how foremen take-home compares with that of the rank and file.

From the few data we have been able to collect, I would say that foremen's wages or salaries are above the average weekly wage paid the rank and file. How foremen are making out in comparison to the top operators, particularly when their takehome is boosted by overtime, is a different matter.

I am under the impression that in the majority of cases foremen earn slightly less than the maximum pay of the men they supervise. Whatever the reasons for this practice, and there may be some good ones, I personally consider it poor policy. If a foreman is good enough to supervise all the men on his floor, including the top producers, he is also good enough to receive at least as much as they do. If he is not good enough to earn more, the company should either help him to improve his usefulness, or else replace him with a better man.

Of course, there are quite a few companies where the foremen earn from five to twenty-five per cent more than the top rate paid to the men under their supervision. Since, in our civilization, a person's earnings indicate his relative rank within the social pyramid, this is as it should be.

This does not mean that I am unaware of the value of non-financial inducements to either better workmanship or better leadership. On the contrary, it is my observation that among the non-financial inducements, sharing of information and sharing of social occasions are among the most effective. Where foremen and other supervisory people are given access to the information and thoughts their superiors have, a great sentimental barrier to the foremen's identification with management has been taken down. How can this be accomplished?

In some companies it is being accomplished through so-called "executive development committees." Foremen get together with their superiors — either once a week or once in two weeks — and listen to discussions of problems and situations which affect one or the other aspect of the company's affairs. Foremen and all other participants can ask whatever questions they wish, and every effort is made to answer them fully and frankly.

This work is sometimes supplemented with regular messages to all members of management, including the foremen. These messages, given in either memo-form or via the telephone, deal with finances, taxes, production, labor relations, or any other topic with news value and of interest or concern to management.

Other companies are trying to accomplish the same purpose by running, either within the plant or at some more convenient location, regular dinner and instruction meetings — with all members of management attending again including the foremen. Top management per-

sonnel or specialists from universities or other companies lead discussion sessions on economic conditions as they affect the company or industry involved. They may discuss topics ranging from profit sharing or guaranteed employment to the problems of time study and motion economy, the principles of testing for job qualifications, the work methods and characteristics of executives, and any other subject of special importance to the company involved.

In an attempt to evaluate these and other methods of supervisory development, it is well to realize that the accent is on "development," not on "training." People can be "trained" to perform certain manual or mental operations. But you cannot "train" them to acquire an attitude or approach to their jobs, and you cannot develop them into managers by "training." What you want to do is "condition" them — which you do by exposing them to your problems and situations. This is the general idea in back of all the methods and devices I have mentioned.

It is implied in what I have been saying that top management must take the initiative in supervisory development, and it must actively participate in all its phases. This does not mean that top management should decide every detail of the development process. On the contrary, having set the organizational framework for this conditioning, you can leave it pretty much to your foremen and supervisors to decide just what the subject for any discussion or course should be. But what top management should never fail to do is to give all the assistance it can — by way of offering the participation of its own or outside specialists, and experts.

SUMMARY

Supervisory development of any kind is doomed to failure if top management proceeds on the assumption that foremen are dumb people; that they are men whose interest, if any, lies outside the plant. It has been my experience that really dumb people are quite rare. But it has also been my experience that many people do not have the information and knowledge they should have. They would have that knowledge if they were helped to acquire it.

Most of us, and this is true of you as it is of foremen, would like nothing better than to live their jobs and to make a lifetime adventure out of their work. Supervisory development offers the opportunity to do just that. It makes the individual's job meaningful by demonstrating its many aspects and responsibilities. And it makes his job take on the value of team-work by showing how it relates — how it influences and is influenced — by all the other activities that make up the total phenomenon of the company.

There is no business that does not have all the components of the universe. What we have to learn, and what we have to make our associates find out — is that this universe lies enclosed in our work. In this way and in this way alone, will we bring to an end the segregation and loneliness of the people on whose cooperation and goodwill every company depends.

Supervisory development — and I might add, executive development — is the road we must take if we want to change the job from a way of making a living to a way of life.

DISCUSSION

PRESENTED BY

F. H. CASSELL, Supervisor Industrial Relations, Inland Steel Co., Indiana Harbor, Ind.

A. C. CROFT, President, National Foreman's Institute, Inc., New London, Conn.

W. J. TUNNY, Superintendent Electrical Maintenance, Youngstown Sheet & Tube Co., East Chicago, Ind.

F. H. Cassell: You mention the morale problem of the supervisor which involves his inability to have his grievance processed through the higher levels of management. I am wondering if you have any suggestions on the basis of your experience as to how a company can establish the equivalent of a grievance procedure for supervisors.

A. C. Croft: The common complaint of foremen is that there is no grievance procedure as far as they are concerned. They get it from both ends, and live with it. Some very successful grievance procedures that I know of are those whereby foremen can have conferences with top plant management, with a vice president, on problems that trouble them and which they feel are not answered satisfactorily by their immediate superintendent.

Foremen's complaints occur with a greater frequency, of course, with over-time work without any extra compensation, and with the increasing pressure coming to them now. The fact that they are going to be obliged to operate with fewer people, and are expected to turn out more production, is another source of irritation.

There should be some procedure in every company, it seems to me, for handling foremen's grievances. The best procedure that I can recommend out of my experience, is a procedure that involves the foreman's superintendent, and top plant management.

F. H. Cassell: How do you protect the supervisor, or even the unorganized worker, from his supervision if he happens to go to the top management and air a grievance?

A. C. Croft: The best protection is a sense of fair play throughout the organization. In our experience, the best way to handle foremen's grievances is with top management taking part, where there is an atmosphere in which tension is relaxed and there is a definite understanding that there will be no marks in the "Black Book" against any foreman for whatever he may say during the meeting.

I am thinking of an experience I had in a railroad shop recently. We were having a foremen's conference and one of the superintendents was present. A foreman said, "The thing about this shop that I don't like is that it is an Abe Lincoln shop." I have heard a lot of stories mentioning Abe, but I knew this was only an opener, and that he wanted me to ask what an Abe Lincoln shop was, so I did. The foreman explained: "I

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have read that Abe Lincoln had to carry his papers in his hat because he had no desk. I am in the same fix because I have no desk, either."

In the relaxed atmosphere of the conference, a number of foremen voiced their grievances. They did not have a special place to park their cars. Some did not have desks. You would have been interested to see how these grievances were brought out into the open, discussed in a good-natured, give-and-take manner, and solved by top management's counsel, all with the best of feelings.

Try to get your president to foster conferences in this spirit, where the foremen can bring up some of the problems that are troubling them. With tact and skill, many of the human relations difficulties can be ironed out, such as individual grievances of working hours, of pay, and that bugaboo of the foremen—being overruled.

You know that many foremen today side-step the first grievance procedure of their workers for that reason. They do not want to take a chance of being overruled, so that, many times, they go along with situations just to keep everything quiet. I think it is very important that foremen should know that their top manager is going to give them fair breaks in clearing up their own grievances and give them reasonable support when they are dealing with the workers in the company's interest.

W. J. Tunny: How often should the superintendent meet with the foremen as a group, and also, individually?

A. C. Croft: I think you are referring now to conferences that he might have with his foremen, and having to do with work problems, not production meetings. It seems to me that the superintendent, to get the maximum results from the foremen, might well have a monthly dinner, at which time he discusses the work habits of those foremen attending, and comments on them. At the same time, he can discuss with them some of the things that he is trying to accomplish, so that they have the feeling of participation.

The point I want to make is that I can train foremen to follow the normal procedures of good human relations, but I cannot condition them to use them. Your problem in industry is that most supervisors know what they should do, but the big thing is to get them to want to do it—to want to work at the job; to want to do the things they know they should do. If the superintendent can get his men together on a semi-social basis, have them feel that they are his partners, give them a little more information, he will have better team operation .

What would you think of a football team if only the quarterback and a couple of backs knew the signals, and the line men did not know the play? Everybody has to know what you want to accomplish. You can get that across with an atmosphere of understanding. Good conference procedure fosters such an atmosphere.

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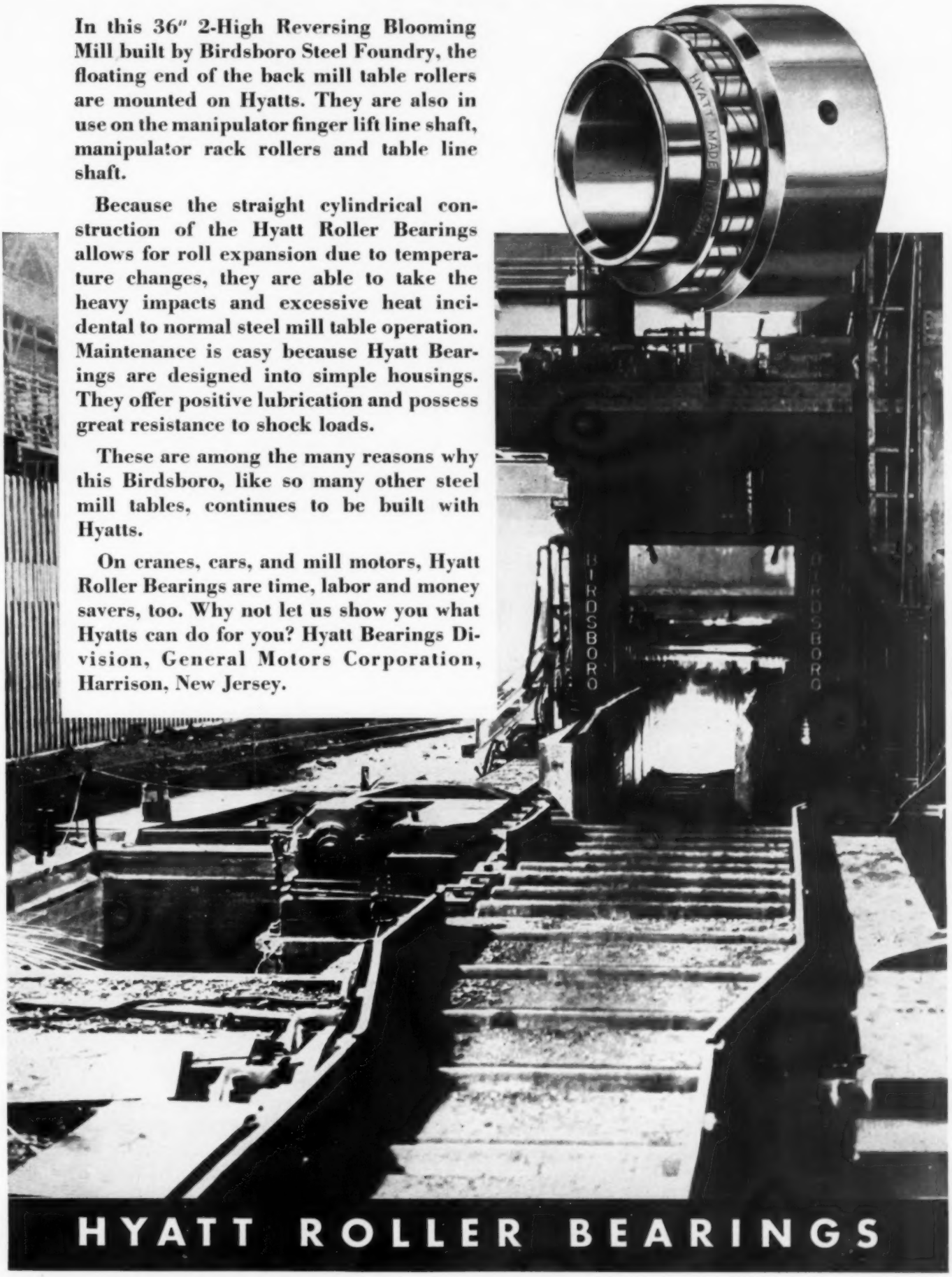

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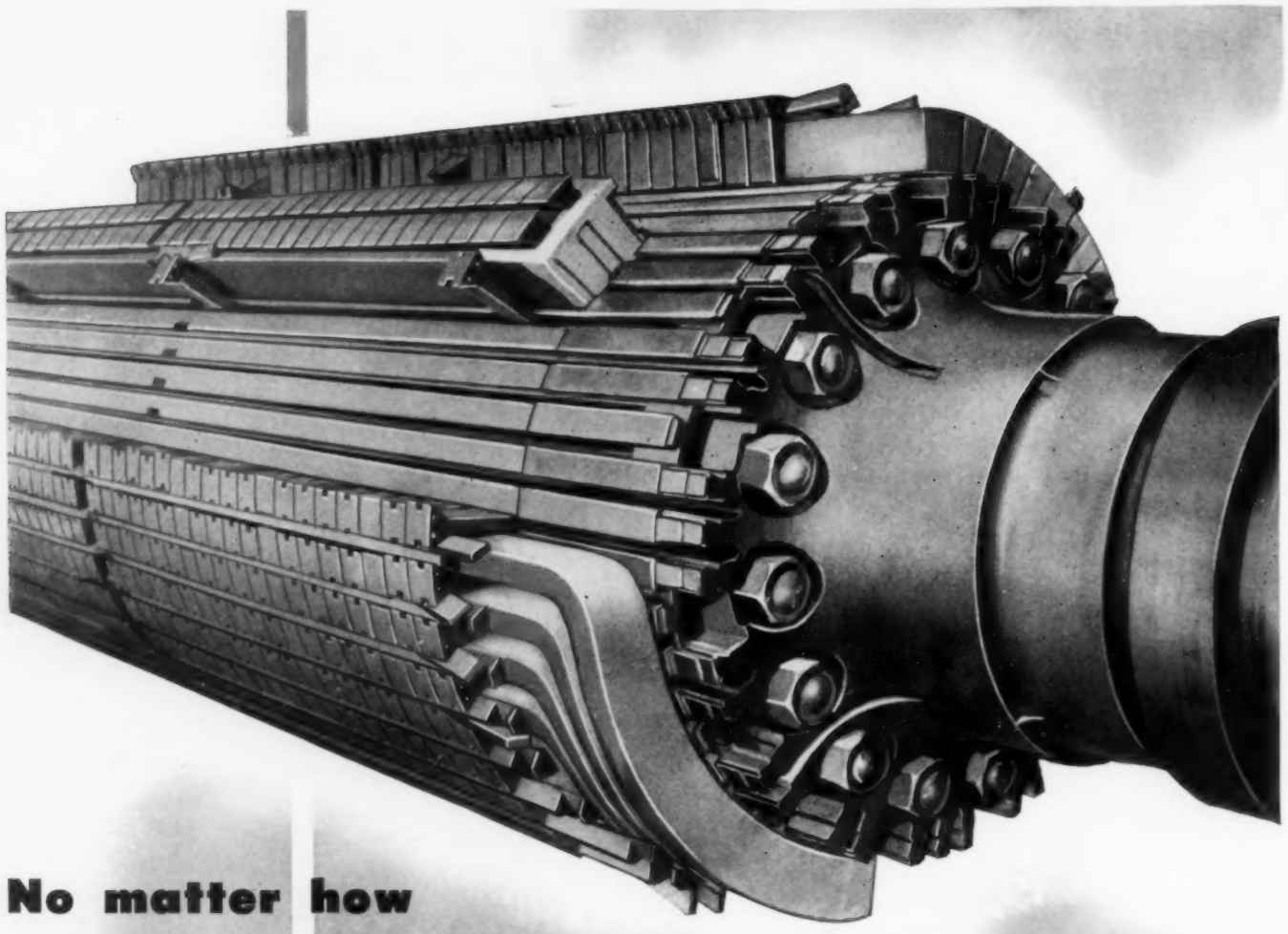

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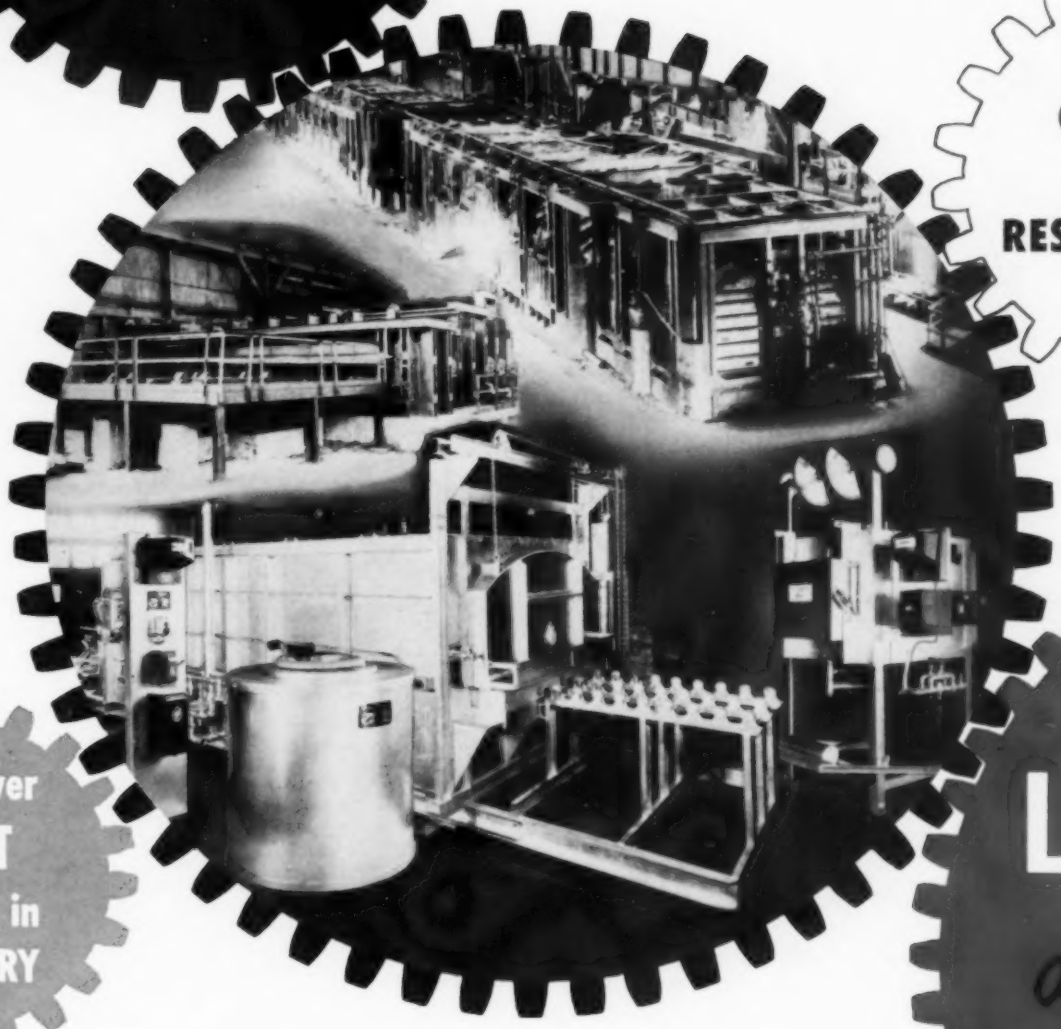

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HANDLING IMPORTED ORE

By G. H. ATWOOD
Chief Engineer
Crane and Bridge Dept.
Dravo Corp.
Pittsburgh, Pa.

▲ The extent to which new ore unloading facilities on the Eastern Seaboard are required depends upon how much ore would be imported and, of this total, how much could and would be handled over existing docks, both private and of the common carrier type, and to what extent ore would be moved inland in greater quantities than heretofore.

Early in 1950, the Baltimore and Ohio Railroad Co. decided to construct a huge import pier at Curtis Bay in the Port of Baltimore. This location was particularly favorable as the site is immediately adjacent to The Baltimore and Ohio Railroad Company coal pier where the loading out of coal for water transportation makes available empty railroad cars which can be loaded with ore. Thus, these cars can to a considerable extent be utilized in a two-way movement whereas up to the present time they have been largely in a one-way movement only.

Dravo Corp., Pittsburgh, Pa., was awarded the contracts for the ore unloading and ore handling facilities at the new pier. It is the purpose of this paper to describe in some detail this particular portion of the entire project. The ore pier itself was designed by The Baltimore and Ohio Railroad Co. engineers who also developed a complete plan for handling the ore.

The pier itself is of the along-shore type with single water side and consists essentially of two paralleled reinforced concrete dock walls supporting unloader tracks on 65-ft centers, all carried on cast-in-place concrete piles. In its initial phase the resulting dock is 650 feet long by 80 feet wide.

Mounted on, and traveling along, the length of the pier are two steel unloading towers which transfer the ore (iron, chrome, manganese, etc.) from the ocean-going vessels to a single belt running along the dock, parallel to the vessel and beneath the unloaders and which, in turn, delivers the ore into a discharge bin located over the loading tracks of the railroad yard. From the discharge bin the ore is fed to scale hoppers, is automatically weighed, and is discharged to railroad cars which have been spotted in position by a pusher engine. The entire system is of balanced design to insure the rapid, continuous, economical handling of ore from the vessels and into the cars for shipment to whatever destination may be required.

At the outset certain fundamental requirements were established for the design. By its very nature as a common carrier dock The Baltimore and Ohio Pier would be required to handle whatever materials were offered to it and to unload from whatever type of vessels in which this material might be carried. Accordingly, the minimum cubic and resulting tonnage capacities were based upon ore weighing 150 lb per cu ft but all mechanical, structural, and electrical parts were designed to handle equivalent cubic of ores weighing 200 lb per cu ft. The systems were designed to accept ores ranging from granular to 24-in. lumps insofar as gate and chute sizes, feeders and hoppers were concerned, but it was ultimately decided to screen out the larger lumps should these be encountered and a grizzly or bar screen having 15-in. square openings was provided above each unloader feeder hopper.

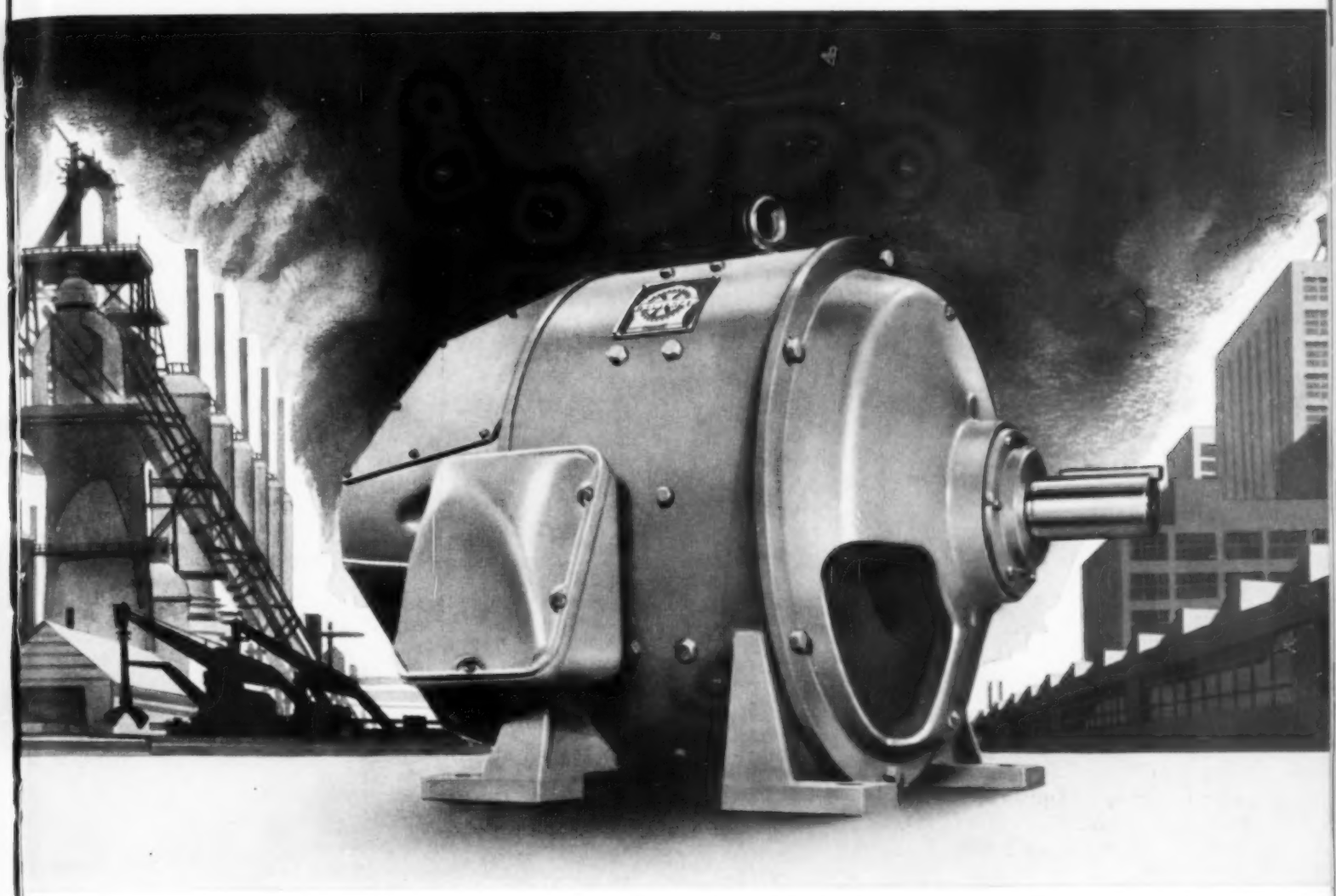
The problem of ship hatches was met by providing buckets having capacities of 200, 120, and 60 cu ft, respectively. The larger bucket has a nominal rated capacity of 15 net tons when handling 150-lb ore or 20 net tons when handling 200 lb ore and was intended primarily for rapid emptying of the more modern vessels having favorable size hatches. The smaller buckets are of the digging type.

The two unloaders are identical and each machine consists of a traveling structural tower having a span of 65 ft and a distance center to center of legs along runway rails of 45 ft. The tower supports a horizontal runway for a man trolley which provides for an overall trolley travel of 200 ft and which is made up of a front of water side cantilever providing for a working travel of 70 ft from the front legs of the tower (or 60 ft from the front face of the dock), a fixed runway through the tower of 65 ft length, and a rear or land slide cantilever providing rear working travel of 65 ft.

The front cantilever is in the form of a hinged apron which can be raised to clear ships rigging. When in the fully raised position the apron is automatically latched securely in position. Engagement with the latch is customarily not made unless the unloader is to be standing idle for a

Figure 1 — The new ore unloading pier is designed to move the material directly from the ship to the railroad car. A 12,000-ton vessel, such as the one illustrated, can be unloaded in six hours.

The Toughest Motors Ever Built...



...for the toughest jobs in plant, mill or mine

Reliance has concentrated on the manufacture of constant *and* adjustable-speed motors for nearly 50 years. Working with users of motor drives in every industry, Reliance engineers have constantly improved their basic heavy duty design to maintain the recognition of Reliance Type 'T' as "The Toughest Motors Ever Built". Proof of this recognition lies in the fact that they continue, year after year, to be the work-horses of American industry. When these tough Type 'T' Motors are put to work for you they will prove their ability to deliver dependable power—*longer.*

RELIANCE
TYPE 'T' HEAVY DUTY
D-C. MOTORS

Facts behind their outstanding durability

On the Other Side . . .

Sales Representatives in Principal Cities

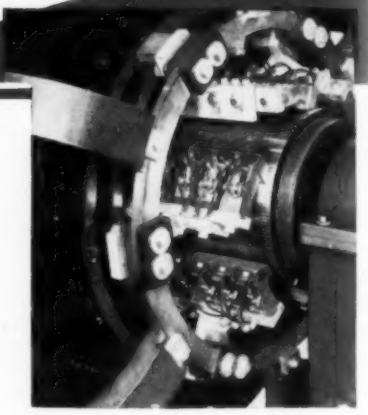
RELIANCE ELECTRIC AND ENGINEERING CO.

1084 IVANHOE ROAD • CLEVELAND 10, OHIO

CANADIAN DIVISION: WELLAND, ONTARIO

RELIANCE Type 'T' Heavy Duty D-C. MOTORS

MANY Extras Make Them THE TOUGHEST MOTORS EVER BUILT!



Heavy Duty Armatures
Precision-Balanced

Armature cores are made of highest grade silicon steel punchings assembled under pressure and tightly held between end flanges. After careful winding, coils are given the maximum protection through Reli-X Insulation. And all completed armatures are dynamically balanced to assure smooth running motors!

Heavy Duty Brushes and Brushholders

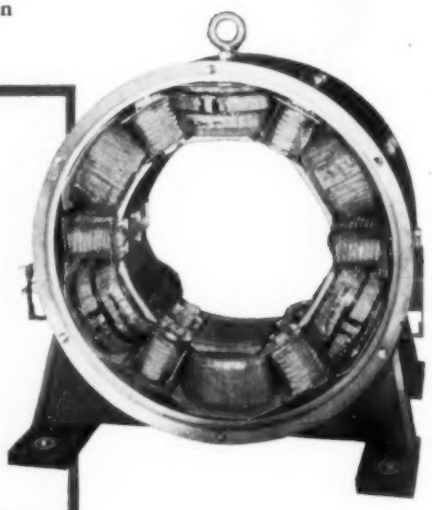
Brushes of high grade electrographite carbon have flexible shunts. Current density is maintained within well-established limits over the full range of load. The particular design of the cast bronze brushholders and precision methods of brush rigging combine to promote smooth operation and good commutation.

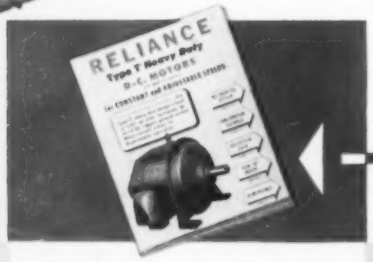
Heavy Duty Shafts
Precision-Turned Finish Ground

Heavy, liberally designed shafts of finest forging-quality steel are precision-turned for accuracy in all dimensions. Each and every shaft is then finish-ground to guarantee additional strength, precision fits and interchangeability.

Heavy Duty Coils
Reli-X Insulated

Precision procedures in winding and assembling coils are followed by the use of selected materials and exclusive methods in the Reli-X Insulation Process. Resulting coil units are compact, yet extra-sturdy —with unsurpassed mechanical protection and insulation at all points.

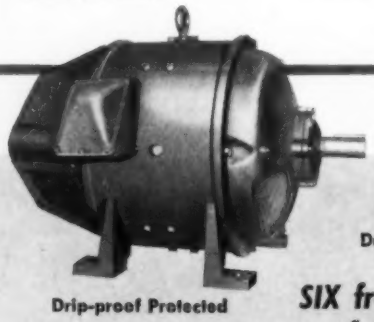




In this new booklet

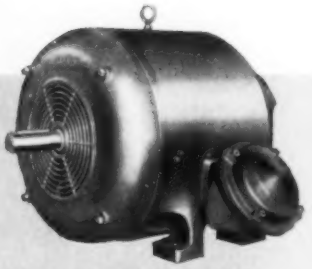
Many Other Important Extras Described in Detail

Here is word and picture proof of all of the many extra precision steps taken in the manufacture of Reliance Type 'T' Heavy Duty D-c. Motors to give you dependable power—*longer*. Also contains data you should have to select the right D-c. motor for any job. Specify Bulletin C-2001 in your request.



Drip-proof Protected

Drip-proof

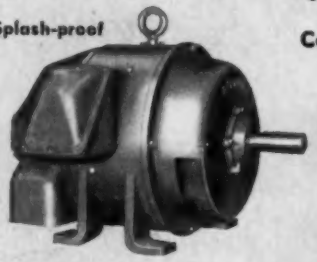


Explosion-proof, Fan-cooled

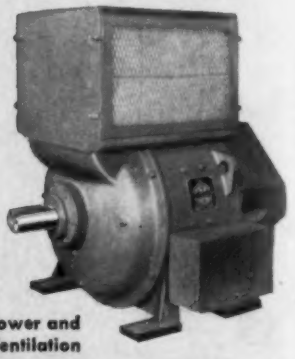
SIX from a COMPLETE RANGE of MECHANICAL DESIGNS

¾ to 1000 Horsepower for Constant and Adjustable Speeds

Splash-proof



Totally-enclosed, Fan-cooled



Integrally-mounted Blower and Filter for Force Ventilation

Sales Offices in Principal Cities

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considerable period. Ordinary movements of the unloader along the dock are usually made with apron raised sufficiently to clear any possible interference and with apron suspended upon lifting ropes. In the lowered position the apron is suspended upon structural eyebar sets which carry all the dead load and live load with the lifting ropes allowed to go slack and carrying no load.

Raising of the apron is accomplished by means of a single drum, direct-connected electric hoist located in a machinery house or apron hoist house at the top of the tower. The raising of the apron requires four minutes and the apron hoist drum is driven by a 65-hp motor through worm and spur gear reductions. The hoist drum is of welded construction 50 in. pitch diameter × 8 ft 10½ in. long and the reeving consists of two ⅞-in. diam ropes with each rope having one end connected to the hoist drum, reeved seven parts over 30-in. sheaves, and with the other end connected to a bar type equalizer at the outer end of the apron.

The rear cantilever is fixed in position landward of the unloading tower and serves an area which may be utilized for the temporary storage of ore in the event it is necessary to unload vessels at a time when for some reason railway cars may not be available.

At the outer end of both the hinged apron and the rear cantilever there is provided a terminal buffer, consisting of coil springs, with a spring capacity which can absorb the full energy of the trolley minus the loaded bucket when traveling at 50 per cent of balanced trolley speed.

The unloader man trolley is of the four-motor type having two hoist motors of 250-hp continuous capacity, force ventilated and two trolley travel motors rated 125-hp one hour. Speed of hoisting the bucket is 250 fpm and trolley travel balanced speed is 1000 fpm. When handling 15 tons of ore in the 200 cu ft bucket, the operating weight of the trolley is 112 tons. With the above motors and speeds the unloader will operate on an average free digging cycle of 45 seconds from ships hold to unloader hopper and under free digging conditions is capable of transporting 150-lb ore at a rate of 1200 net tons per hour.

The bucket hoist consists of two parallel drums each 34-in. pitch diameter, of welded construction, mounted across the trolley, one for the closing motor and one for the holding motor. Hoisting is accomplished by means of both motors operating simultaneously. Each drum is driven by its respective motor through a double helical motor pinion and gear and a spur drum pinion and gear, all operating in oil-tight gear cases. Gears are deep carburized for wear and self-aligning, anti-friction bearings are used throughout. Motor pinion is independently mounted on anti-friction bearings and connected to the motor by means of a flexible coupling.

The trolley is spring mounted on four 33-in. diam tapered tread, single flanged, rim toughened, wrought steel wheels, accurately machined. Each axle is driven by a single motor, cradle mounted, through a deep carburized, double helical gear set.

There is mounted on the trolley deck a ring type turntable for rotating the smaller buckets and consisting of a cast turntable ring equipped with vertical and horizontal rollers and provided with a bevel rack for driving. Rotation is accomplished by a 6½-hp motor producing a turning speed of 9 rpm.

The operating weight of the entire tower is 685 tons and each corner is carried upon eight 30-in. diam, fully equalized, single flanged, rim toughened, wrought steel wheels arranged to travel on 171 lb track rails 2 ft 6 in. centers. All eight wheels on each corner are driven by a 33-hp motor by means of worm gearing connected by universal joints and flexible couplings. Worm sets are 13½ in. centers with one such set being used for each four truck wheels.

Four rail clamps are provided for each tower and these are sufficient to hold the tower against a wind pressure of 40 lb per sq ft without benefit of other devices. The clamping action is furnished by the action of heavy helical springs acting against a toggle to spread the upper ends of the clamp arms which are clearly shown. Release is effected by pulling the arms together by means of a rope reeved system which is winch operated. A recording type anemometer is used which furnished a continuous chart of wind velocities.

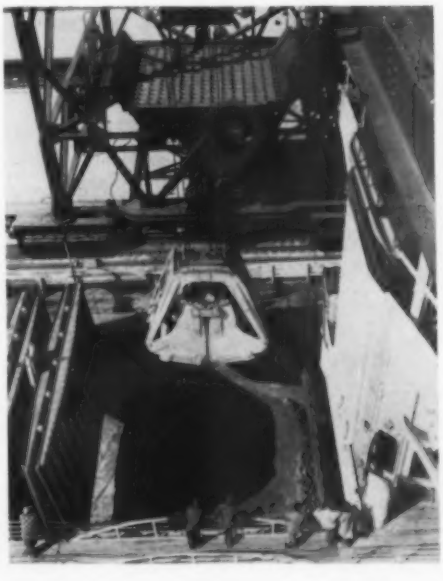
Located beneath each unloader is a heavy duty manganese steel feeder above which is a 160-ton surge hopper arranged to deliver ore to the feeder. Regulation of ore flow is accomplished by means of a ratchet-operated regulating gate which, when set, determines the depth of ore on the feeder. The feeder itself is powered by a 15 hp variable speed motor and rate of feed to belt may be varied from 665 to 1330 tons per hr when handling 150-lb ore. As a part of the hopper and feeder system there is provided a system of rubber impact idlers mounted on the feeder supports and arranged to support the main conveyor belt at any loading point so as to amply support and cushion the belt during loading. A special arrangement of chutes, skirts, and fingers permits the finer material to reach the belt in advance of the larger lumps so that these will be delivered to the belt on a moving bed of finer material, all conducive to longer main belt life.

The main belt is 48 in. wide, travels at 400 fpm and has capacity to handle 2000 tons of ore per hour. In construction it is 9 × 11 ply with ¼ in. top cover with breaker strip and 1/16 in. bottom cover. Canvas duck is 42 ounce and rubber has a tensile strength of 3500-4000 psi.

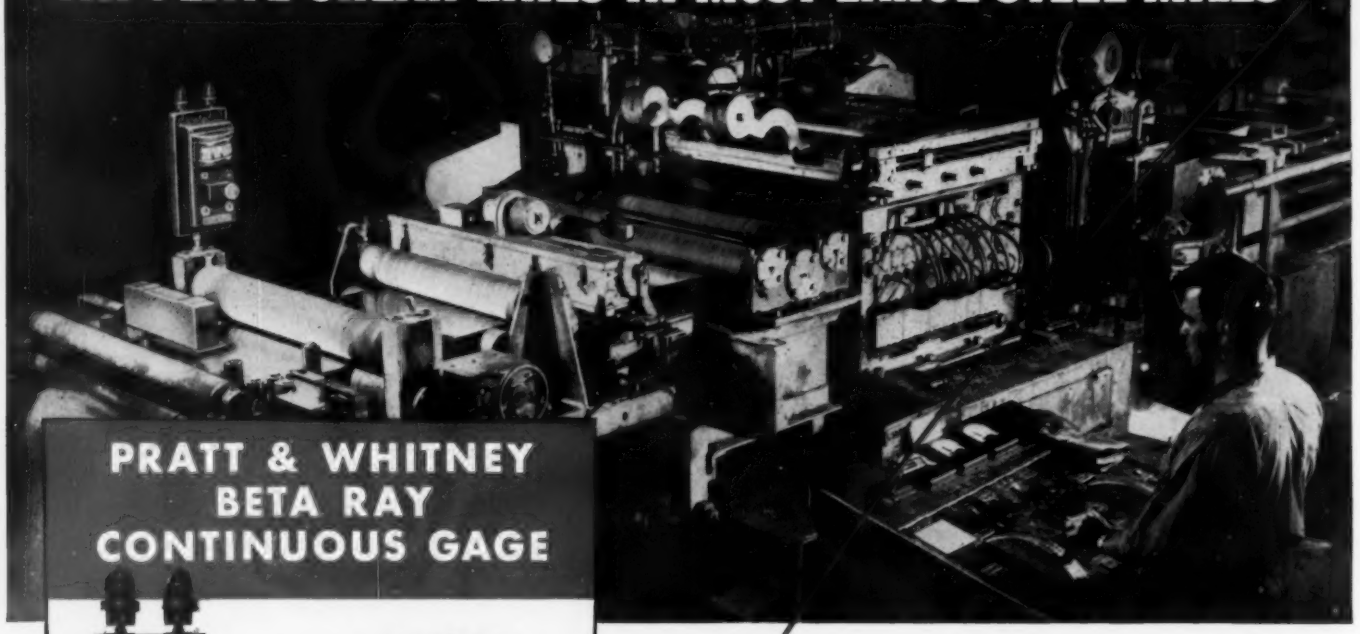
The belt conveyor has a total length of approximately 895 ft, travels horizontally along the dock beneath the two unloaders, rises along a vertical curve of 525 feet radius and ascends on a slope of 16 degrees to deliver ore to the discharge bin.

A two motor belt drive is used with 200 hp used for the primary drive and 100-hp motor used for the secondary drive. Drive pulleys are 72-in. diam;

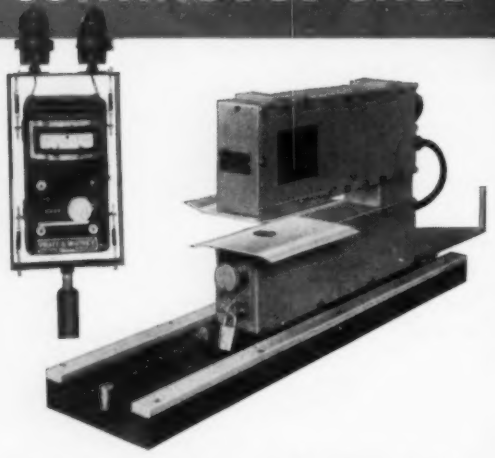
Figure 2 — The 15-ton bucket shown lifts the ore from the hole and empties it onto the grilled top bin which feeds the ore to a conveyor belt.



P&W BETA RAY GAGES AND *Syncro Timer* TEAM-UP FOR PRECISE MEASUREMENT AND CONTROL OF TIN PLATE SHEAR LINES IN MOST LARGE STEEL MILLS



PRATT & WHITNEY BETA RAY CONTINUOUS GAGE



measures thickness *change* of the strip, which is in direct relation to absorption of electrons from radioactive (Strontium 90) source. Control meter indicates change and supplies a controlling impulse to Syncro Timer for sorting off-gage sheets.

Electrical components of Gage made by General Electric Co.

THERE'S no better precision equipment available than the P&W BETA RAY CONTINUOUS GAGE for accurate, non-contact gaging of high-surface-finish strip on electrolytic tin plating and shearing lines.

And, after the strip is cut, the P&W SYNCRO TIMER fits in perfectly for remote-control sorting and diverting of off-gage (light or heavy) sheets regardless of shear line acceleration or deceleration.

Take our word for it — and that of the leading steel mills — this P&W precision-team performs with unmatched efficiency and savings in time, labor and money.

PRATT & WHITNEY *Syncro Timer*

an efficient remote control timing device used in the steel industry for continuous, automatic sorting of sheared sheets. View shows single unit with cover removed.

Installations are completed or in process in mills of the following companies: Jones & Laughlin, Kaiser Steel, United States Steel, Wheeling Steel and Youngstown Sheet and Tube.

PRATT & WHITNEY

Division Niles-Bement-Pond Company
WEST HARTFORD 1, CONNECTICUT

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Birmingham* • Boston • Chicago • Cincinnati • Cleveland
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*Office only

tail pulley is 66-in. diam; snub pulleys are 36-in. diam and take-up pulley is 48-in. diam. All pulleys are welded construction with taper lock bearings. Main drive pulley and secondary drive pulley are provided with vulcanized lagging and herringbone grooves. A vertical counterweighted take-up is employed, located midway along the inclined portion of the conveyor. All belt idlers are 6-in. antifriction type with main carriers being spaced 3 ft on slope and vertical curve and 2 ft 6 in. on the horizontal portion. The primary drive for the conveyor is located in the drive room above the discharge bin.

The belt as shipped to the site is the longest conveyor belt constructed and shipped in a single piece. Field splice for the belt is of the vulcanized type.

Discharge of ore from the main conveyor is into a 500-ton steel hopper below which are located four heavy manganese steel apron feeders identical with those used beneath the unloaders except that at the discharge bin the feeders are powered by 15-hp single speed motors. Each feeder transfers ore from the discharge bin to a spring mounted scale hopper having a maximum capacity of 40 tons of 150-lb ore. Two loading tracks and one pusher track pass beneath the discharge bin structure. The 40-ton scale hoppers are arranged in pairs over each loading track, are each equipped with motor operated double clam gates and discharge the ore to railroad cars approximately over the car trucks. Scales are of the straight lever type and can be preset to automatically weigh out any required tonnage of ore to properly load the car coming into position. They are equipped with dials to show amount of ore in scale hoppers and with printers which are arranged to print both the gross weight and tare weight on special weigh cards thus recording the net quantity of ore delivered to the car. The scale room is suspended beneath the discharge bin and between the scale hoppers.

The entire unloading, conveying and weighing out equipment is designed to handle 150-lb ore at the rate of 1500 tons per hour or the heavier ores at increased rates.

Power for operation of the equipment is 230 v, d-c. Main power supply to the site is at 13,200 v, a-c carried into a sub-station where transformation and tube rectification are employed to produce the required direct current working voltage.

Full magnetic control is used generally throughout the entire system and necessary safety interlocking and limit switch protection is provided.

Control of the unloader is from the operator's cab on the man trolley where are located the master switches for trolley hoist and travel and for unloader tower travel as well as means for control of the unloader feeders. The trolley hoist provides dynamic braking lowering and limit switch protection is provided in the up direction. Trolley travel is equipped with reversing plugging control with limit switch slow downs and final stops at either end of the trolley runway operative when speeds are excessive.

Main conveyor may be stopped and started from conveyor drive house and from scale house below while unloader feeders may be stopped and started from man trolley operator's cab or from station on tower at dock level. The main belt and unloader feeder are interlocked so that stopping of the main belt will stop the apron feeders and these feeders may not be started unless the main conveyor is running. Colored indicating lights are provided to show the operator whether unloader feeders are operating and in case of stopping of feeders, other lights indicate from which point the feeders were stopped.

At the discharge bin, paddle type bin limit switches are provided to prevent the ore from overflowing the bin by stopping the unloader apron feeders while hopper still can receive ore remaining on belt or by stopping the main conveyor when discharge bin is full.

The weighing of ore and operation of scale hopper gates and hopper feeders is semi-automatic. The filling of scale hopper is automatic to the predetermined weight set on the dial by the operator. The feeding of the ore to the scale hoppers is started automatically by the closing of the gates at the bottom of the hopper and loading of the scale hopper continues until correct weight has been reached, after which the feeder is automatically stopped. Opening of gates to discharge the ore performed by push button and the closing of the gates repeats the cycle.

The complete installation described herein represents a modern high speed, efficient ship unloading and car loading system. Presently anticipated imports are expected to work the system to capacity but should the trend show increasing demands for seaboard unloading, the design established by The Baltimore and Ohio Railroad is such as will permit the increasing of capacity by the installation of additional units.

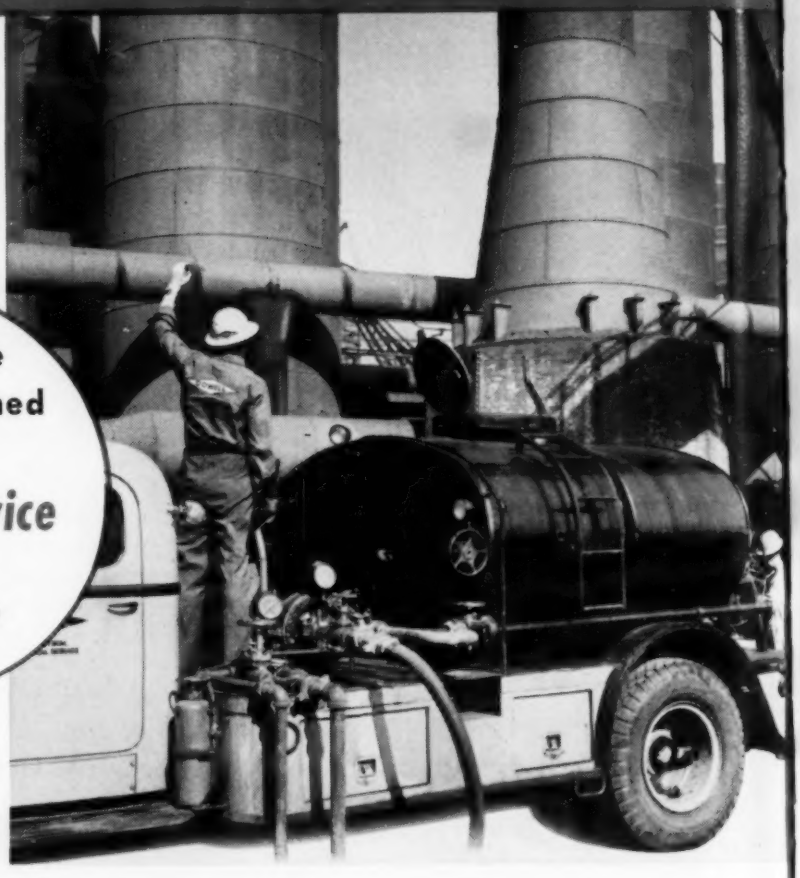
Figure 3 — Ore is carried by conveyor to the scale house shown in the background from whence it is weighed and dumped into railroad cars.

DOWELL

SERVICE SPECIALISTS IN MAINTENANCE CLEANING PROBLEMS

No Shut Down for Cleaning!

Full Furnace Wind Maintained While *Dowell Service* Cleaned Gas Washer



A blast furnace gas washer was operating with 23″ of water pressure drop while scrubbing 60,000 cu. ft./min. of blast furnace gas. Cleaning was imperative. *In two hours,* Dowell Service reduced the pressure differential of the washer to a normal of 7″ of water. The furnace top pressure had fallen from 60″ to 40″. At no time during the cleaning was it necessary to reduce the wind or in any other way interrupt gas washing operations!

Dowell Service, using the experience of thousands of successful jobs, offers you the solution to maintenance problems of this kind. It is backed by strong, continuous research programs, both in Dowell's own laboratories and in those of The Dow Chemical Company. This research provides the means for a constantly improving service with an ever increasing degree of effectiveness and safety.

Dowell engineers have effectively cleaned many other types of steel plant equipment including furnace cooling systems, pipe lines, precipitators, coke plants, cooling jackets and power generation equipment. In all cases costly down time has been held to a minimum. No special scaffolding or extensive dismantling is required for Dowell Service. The special liquid solvents are pumped into the equipment through existing connections.

Call the nearest Dowell office for more details and free estimates on the cost of cleaning your equipment.

DOWELL INCORPORATED · TULSA 3, OKLAHOMA

SUBSIDIARY OF THE DOW CHEMICAL COMPANY

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Philadelphia 2	Detroit 2	Houston 2	Salem, Illinois
Baltimore 18	Chicago 2	New Orleans 12	Borger, Texas
Wilmington 99	St. Louis 8	Ft. Worth 2	Midland, Texas
Richmond 19	Indianapolis	Shreveport 69	Wichita Falls, Texas
Atlanta	Louisville	Anniston, Alabama	Lafayette, La.
Buffalo 2	Kansas City 8	Mt. Pleasant, Mich.	

Long Beach, Oakland, Casper: Dowell Associate—International Cementers, Inc.

DOWELL

A SERVICE ORGANIZATION

Date-line Diary...

May 1

▲ Allis-Chalmers reported net income of $4,579,755, billings of $87,305,871 and bookings of $140,823,104 for the first quarter of 1951. The backlog on March 31 was about $180,000,000.

May 2

▲ Jones & Laughlin Steel Corp. ordered a pusher type billet reheating furnace for Aliquippa from Salem-Brosius, Inc.

▲ Labor and Commerce Departments announced that construction work set a new record in April of $2,353,000,000.

May 4

▲ American Railway Car Institute reports that deliveries of new freight cars in April totaled 8274. Orders totaled 6228, leaving a backlog at the end of the month of 155,871.

May 5

▲ The NPA slashed steel for autos from 80 to 75 per cent of the average rate in the first half of 1950.

May 6

▲ The Securities and Exchange Commission reported that working capital of United States corporations rose $5,700,000,000 during 1950 to $75,800,000,000 at the end of the year. Current assets increased $21,900,000,000 to a record high of $150,500,000,000. Current liabilities are $74,700,000,000.

May 7

▲ Based on reports from companies having 93 per cent of the capacity of the industry, the operating rate for the week beginning May 7 is 103.7 per cent of capacity. This is equivalent to 2,073,000 tons compared with 2,079,000 one week ago.

▲ The August Thyssen Co. at Hamborn, Germany started operation of its first steel furnace since the war.

May 8

▲ The Aluminum Association reports that the industry produced 140,044,429 lb of aluminum in March to bring the total for the first quarter up to 401,431,462 lb, or about 25 per cent more than the first quarter of 1950. Production of aluminum sheet and plate in March totaled 99,965,985 lb to bring the quarter total to 306,771,995 lb.

May 9

▲ Deputy Petroleum Administrator Brown forecasts natural gas shortages in some major cities this coming winter.

May 10

▲ The F. W. Dodge Corp. announced that construction contract awards in April totaled $1,374,991,000 in the 37 states east of the Rockies, or about 8 per cent over last year.

▲ Republic Steel Corp. signed an agreement with General Motors Corp., in which GMC will loan up to $40,000,000 to Republic to help finance its expansion program. Loans plus interest will be repaid with steel products.

May 11

▲ Hoster Steel Corp.'s electric furnace and bar mill now under construction should be in operation in August. The company is located in Oklahoma City.

▲ RFC reduced tin prices 3¢ to $1.39 a lb.

May 13

▲ U. S. Steel Co. has contracted for two billet mills from United Engineering and Foundry Co. for the Fairless works. One unit is a 30-in. 6-stand continuous vertical and horizontal mill. The other is a 21-in., 4-stand continuous vertical and horizontal billet mill. U. S. Steel also ordered a high speed 40-in. reversing blooming mill from Continental Foundry & Machine Co. for the Fairless works.

May 14

▲ Sharon Steel Corp. announced that it purchased 142,500 shares of the common stock of the National Supply Co., Pittsburgh, Pa.

▲ Based on reports from companies having 93 per cent capacity of the industry, the operating rate for the week beginning May 14 is scheduled at 103.9 per cent capacity. This is equivalent to 2,077,000 tons compared with 2,073,000 tons one week ago.

▲ The electrical equipment of the 46-in. blooming mill being installed at Jones & Laughlin, South Side works is being furnished by Westinghouse Electric Corp. at a cost of about $2,500,000.

▲ Northwestern Steel & Wire has ordered two electric furnaces rated at 125-130 ton capacity.

▲ The railroads started their plea before the ICC for a 15 per cent increase in freight rates.

May 15

▲ Certificate of necessity granted New England Steel Development Corp. has been extended to July 11.

▲ Columbia Gas System cut back their 1951 construction program because of a scarcity of steel pipe.

▲ The M. A. Hanna Co. announced that a new company has been formed to operate two new 30,000-ton iron ore carriers, which have been ordered from two English shipbuilding companies. The ore carriers will be the largest ever built, and will be used to carry Labrador ore to the east coast. Delivery is expected late in 1955.

▲ American Iron and Steel Institute reports that employment during March set a new record with about 663,100. Hourly payments averaged $1.92 during an average work week of 40.4 hrs. Total payroll for March was about $238,318,000.

May 16

▲ Charles E. Wilson, president of General Motors Corp., estimates that steel production may be adequate for both civilian and defense needs in another six to ten months.

▲ Bethlehem Pacific Coast Steel Corp. went to Superior Court to prevent Los Angeles County Air Pollution Control District from forcing it to shut down three 50-ton open hearths. Bethlehem wishes to continue operations until a new 75-ton electric furnace is ready for operation.

▲ A new company, Independent Aluminum Corp., is being formed by Metal Trims Inc. and Himmel

Brothers for the purpose of constructing a 120,000,000 lb aluminum reduction plant in the Pacific northwest.

▲ Cost of ferro-tungsten was raised to $5.00 from $3.25 per lb.

May 17

▲ Oliver Iron Mining Co. broke ground today for a pilot taconite beneficiation plant at Mountain Iron, Minn. Plant will have annual capacity of 500,000 tons of concentrates, and will be in operation in the summer of 1952.

May 18

▲ The NPA ordered iron and steel producers to set aside larger percentages of their output in July for defense work.

▲ NPA told consumer durable goods makers that they will be allowed about 70 per cent as much steel, and 60 per cent as much copper and aluminum in the third quarter as their average use in the first two quarters of 1950. Freight car builders are getting a 23 per cent cut in production, and steel is being allocated to make 7600 cars a month compared with a previous 10,000 units.

May 19

▲ Bureau of Labor Statistics report that workers employed in metals and metal producing industries dropped 40,000 to 7,200,000 on April 15.

May 20

▲ Commerce Department stated that nation's production in the first quarter of 1951 was at an annual rate of $314,000,000,000.

May 21

▲ Based on AISI reports of companies having 93 per cent capacity of the industry, the operating rate is scheduled at 103.6 per cent of capacity for the week beginning May 21. This is equivalent to 2,071,000 tons compared with 2,077,000 tons one week ago.

May 22

▲ National Steel Corp. declared a 75¢ a share dividend for the second quarter of 1951.

▲ Supreme Court, in a decision, ruled that retailers are not bound by agreements to prevent price cutting if they are not signers of such agreements.

▲ Otto Herres of the Defense Mineral Administration predicted that zinc shortages will last two or three years.

▲ Tennessee Steel Co., Oneida, Tenn., was granted a certificate of necessity to write off $9,580,000 worth of new facilities.

May 23

▲ The AISC reports April bookings of fabricated structural steel totaled 257,658 tons, shipments totaled 192,590 tons, leaving a backlog for the next four months of 806,763 tons.

▲ The Navy asked Congress to approve construction of a plant at Detroit for aircraft engines at an estimated cost of $35,000,000.

▲ The import duty of 2¢ a lb on copper was lifted until February 15, 1953 in a bill signed by President Truman. Duty may be reimposed if domestic copper price falls below 24¢ a lb or if present national emergency is ended.

May 24

▲ NPA ordered increases in the amount of stainless steel to be set aside for defense needs for the third quarter of 1951. Samples of the increases are set asides of ingots which are raised from 25 to 75 per cent of production, rounds from 50 to 100 per cent, structural shapes from 0 to 100 per cent.

▲ The DPA announced that its survey of the expansion program shows that accelerated amortization has been granted to the basic materials producing industry for facilities costing about $4,045,300,000.

▲ Eugene M. Grace said that the steel industry is reaching a point where it will soon be able to take care of defense needs, and have a liberal supply for civilian production.

May 25

▲ Granite City Steel declared a quarterly dividend of 55¢ a share.

▲ Crucible Steel will shut down one of its blast furnaces July 1 for relining.

▲ Volta Redonda set a new steelmaking record with 420,188 metric tons. Pig iron production totaled 339,062 metric tons.

May 28

▲ AISI reports that the operating rate of the steel industry beginning May 28 is scheduled at 102.7 per cent of capacity. This is equivalent to 2,053,000 tons compared with 2,071,000 tons one week ago.

▲ Texas Gas Transmission Corp. outlined to the RFC plans for a $45,300,000 pipe line project to bring more gas to La., Ark., Miss., Tenn., Ky., Ind. and E. Ill.

▲ Pittsburgh Steel Co. and Thomas Steel Co. agreed to merge today. Each share of Thomas Steel common will get 1/3 share of common of Pittsburgh Steel, and 1/3 share of 5½ per cent prior preferred stock.

May 29

▲ Supreme Court upheld CBS's system for broadcasting colored television.

▲ DPA Administrator Gibson predicted that rearmament will take 40 per cent of nation's steel production in the third quarter, compared with 8 per cent in the present quarter.

▲ International Nickel Co. announced an increase in the price of nickel effective June 1 of 6¢.

May 30

▲ Senator Maybank said that he is going to seek a change in the way the 5-year tax amortization program is being handled.

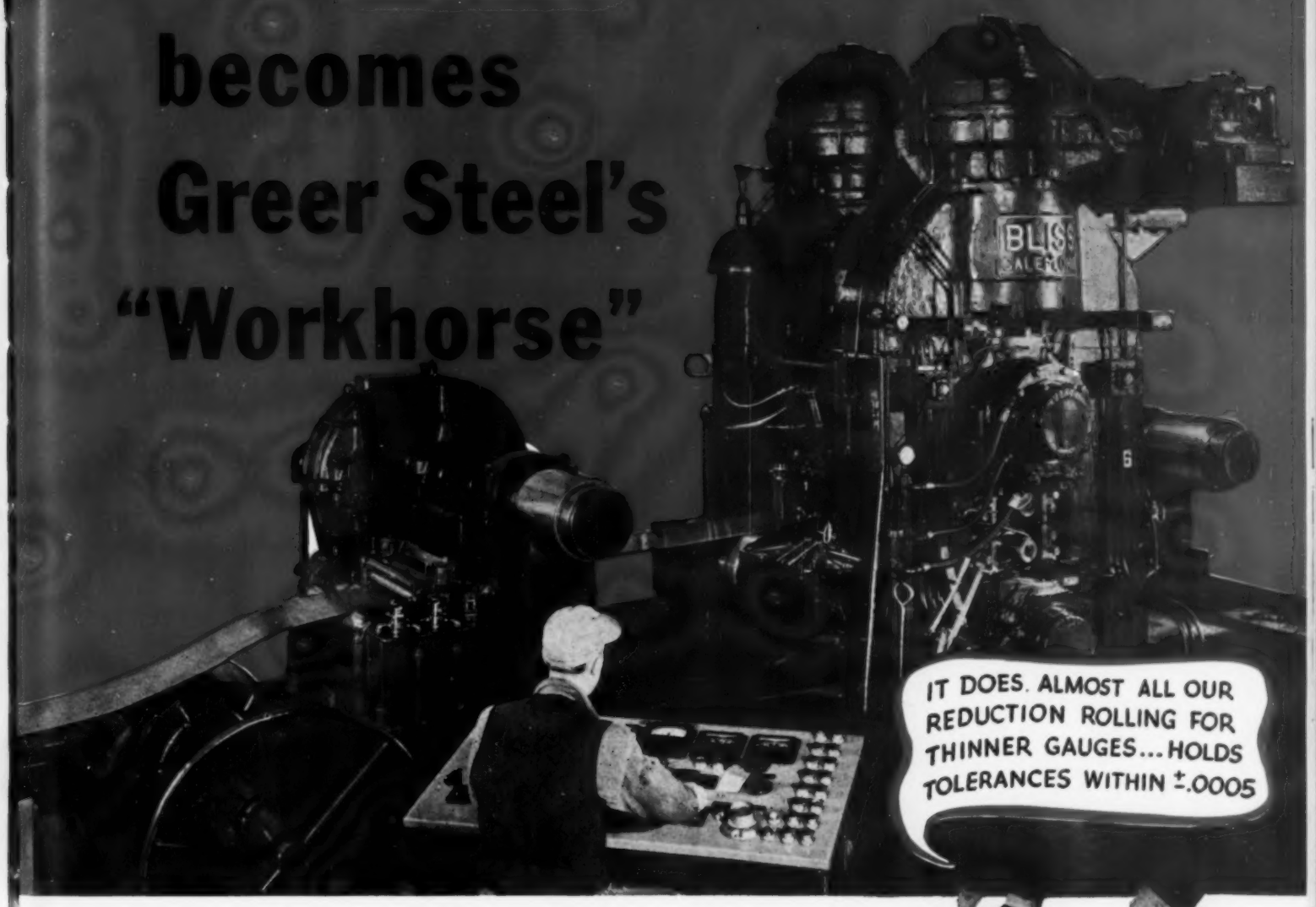
▲ Predictions are being made that ore shipments in 1951 on the Lakes will be about 90,000,000 tons, or 15 per cent greater than last year.

▲ Fontana steel put into production its eighth open hearth furnace.

May 31

▲ A new semi-continuous steel pickling and processing line is being installed for American Tool and Supply Co. in the former Pressed Steel Car Co. plant in McKees Rocks, Pa. Operations are scheduled to start June 15.

New BLISS Reversing Mill becomes Greer Steel's "Workhorse"



It takes a rugged, versatile mill to maintain exacting standards for quality of finish and accuracy of gauge on short runs and quick changeovers. A new Bliss 4-high reversing mill, specially designed to meet "job-shop" requirements, was the answer for the Greer Steel Company, Dover, Ohio.

The new Bliss mill has oversized sections to take severe usage. It has material-handling aids and precision controls for quick and safe changeovers. Already known as "the Greer workhorse," because it handles practically all the heavy draught work at Greer, the Bliss mill rolls carbon and alloy steels in all tempers. Reductions of 25% on the first pass are not unusual. Metal thicknesses are reduced as much as 90% and finish gauges as thin as .005". Tolerances at times are held within .001". Mill speed regularly exceeds the rated 1000 fpm.

Greer also likes its new Bliss mill because every practical feature for its universal usage is built in. This includes a back-up roll changer (concealed in floor when not in use), coil box, roll breaker, expanding mandrels and sticker guides.

Bliss rolling mill engineers can meet your special requirements, too. Write for further information.

E. W. BLISS COMPANY, General Office: Canton, Ohio
ROLLING MILL DIVISION: SALEM, OHIO

Is OVERHEATING your magnet problem?

The husky load of scrap in the photograph weighs practically the same as the first load lifted eight hours earlier. Why?

Ohio Magnets lift efficiently—*uniformly*—over extended periods of operation because they operate *cooler*. Copper coils are heavier-duty, carefully sealed with plenty of non-cracking asphaltum.

Uniform lifting capacity is one of the reasons why more mills are standardizing on Ohio. Satisfy yourself. Send your next order to Ohio—*27 years a leader in magnetic materials handling.*

This magnet lifts big loads all day long!

OHIO PROTECTO-WELD MAGNET is welded *on top*, where weld cannot be dented in. Sizes include 39, 46, 55 and 65-inch diameters. Ohio also builds magnet control equipment.

In addition to lifting magnets and control equipment, Ohio Electric also makes fractional horsepower motors, heavy duty electric cable hoists, nail-making machines and drill presses.

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CHESTER BLAND, *President*

Ohio ELECTRIC

A-2027

Industry News...

OLIVER IRON MINING CO. STARTS PILOT TACONITE BENEFICIATION PLANT

▲ An important forward step in the plans of Oliver Iron Mining Co. to tap the vast reserves of low grade iron ore on the Mesabi Range known as taconite was taken recently when ground was broken for a pilot taconite beneficiation plant with an annual capacity of 500,000 tons of finished concentrates. This plant, first to be built by the Oliver Company, will add substantially to the vital supplies of raw materials which the steel industry needs to carry out its national defense program. It is expected that the new taconite pilot plant will be placed in operation during the summer of 1952.

Construction of this plant will be a major part of Oliver's large and costly taconite experimental program. The plans disclosed contemplate further steps in United States Steel's long-range program of research, development and construction in the field of domestic iron ore beneficiation, and exploration and development of foreign sources of ore, which both are needed for our nation's economic growth and security in time of war.

For many years Oliver Iron Mining Co. has been carrying on a program designed to study ways and means of improving the ores currently mined, to experiment with the concentration of marginal ores and taconites, and to determine the most efficient use of these ores in the blast furnaces which supply iron to the steel mills. All of these measures are intended to increase and conserve reserves of high grade domestic iron ore and to add many years to the life of such reserves. The problems encountered have been many and complex in nature.

Extensive basic research in the beneficiation of magnetic and non-magnetic taconites began about eight years ago, when a research laboratory was established in Duluth, the largest and best equipped of its kind in the world, to continue and intensify the pioneering work in the field of low grade iron ore development.

This preliminary work is now bearing fruit in a taconite development program which covers three stages. The first stage was the very intensive drilling of taconite formation to ascertain the chemical and physical characteristics of the material, which are extremely variable. Large expenditures were needed to obtain this basic information. The results of the findings governed the design and arrangement of the equipment to be used in this pilot plant.

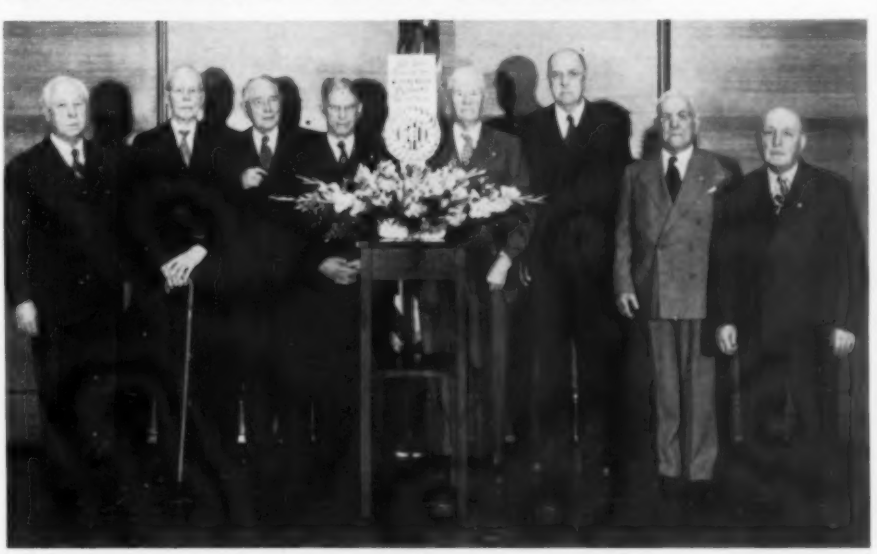
The second stage in the program is the construction of this pilot beneficiation plant, which will separate the fine particles of iron ore from the rock. This will be done by four steps of crushing, followed by two steps of grinding, after which the fine magnetic ore particles will be extracted from the waste materials by magnetic separators. Other equipment will separate the non-magnetic iron from the silica with which it is associated.

Agglomeration, the third stage in the process, will transform the powdery iron ore into pieces about the size of eggs that can be charged into the blast furnaces to produce iron. The agglomerated lumps must be strong enough to withstand freezing and thawing and the rough handling in transportation to the steel plants, and must have qualities necessary for efficient blast furnace operation.

Because of the complexity of the agglomeration problem, which requires considerable time for development, Oliver last year began construction of an experimental taconite agglomeration plant at Virginia, which will produce porous clinkers and egg-shaped nodules.

The project will comprise the development of a taconite mine to be equipped with rock drills, power shovels, and rail haulage with diesel locomotives; the building of shops, offices, and a crushing and beneficiating plant; a water supply system and power distribution lines and sub-

UNITED CELEBRATES FIFTIETH ANNIVERSARY



This year, United Engineering and Foundry Co., Pittsburgh, Pa., is celebrating its Fiftieth Anniversary. All of the men in the above photograph have been in the employ of United throughout its fifty years, Shown, left to right are: F. C. Biggert, Jr., Chairman of the board; William Metcalf, Jr., director; George W. Knotts, director; John Quinn, director and district manager of Canton and Akron, Ohio, district; Robert W. Tener, director; K. C. Gardner, Sr., president; George F. Hunter, molder in Canton, Ohio, plants; and S. Dorsey Wallace, chief timekeeper of the machine and weld shop at the New Castle, Pa., plant.

Straighten Pipe & Tube Up To 24" At High Speed

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MULTICYCLE STRAIGHTENERS

FOR PIPE & TUBE 1/16" TO 24" DIAMETER

THERE IS A DIFFERENCE IN STRAIGHTENERS! Only the Medart Multicycle offers a double straightening cycle, imposed by two bending stations to insure end-to-end straightness.

GENTLER HANDLING OF PIPE WALL! For large thin wall pipe or tubing the Multicycle employs dual-type bending rolls to distribute the straightening load around the tube circumference and eliminate usual single point high pressure concentration.

UNBALANCED TWISTING TORQUE ELIMINATED! Both top and bottom feed rolls are driven on the Medart Multicycle for balanced torque about the neutral axis of the workpiece.

SINGLE DRIVING MOTOR! Only one driving motor is required, insuring positively synchronized roll speed, longer roll life.

NO RUBBING GUIDES! All guiding action is accomplished by rollers mounted in anti-friction bearings — no friction or shoe-type guides are required.

COMPARE THE MULTICYCLE ADVANTAGES! Also straightens solid rounds — motorized setup adjustment on larger models — all gears running in oil — Timken bearing equipped throughout — many other patented features.

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stations; waste disposal dumps, and other related facilities. This will require heavy expenditures, as will the stripping of soil and other layers which cover the taconite formation.

The taconite beneficiation plant at Mountain Iron will be an all-year operation. It will produce 500,000 tons of iron concentrates a year from approximately 2,000,000 tons of hard taconite rock located nearby. After beneficiation, the concentrates will be transported to the agglomerating plant at Virginia, where they will be appropriately processed and shipped by rail and ore boats to steel plants at the lower lakes for testing in large, modern blast furnaces. The operation of these furnaces with charges of taconite agglomerates will be studied carefully to determine the best conditions for taconite use to effect the maximum increase in pig iron production.

REFRACTORY FIRM TO BUILD WARREN PLANT

▲ General Refractories Co. has purchased a 29-acre tract of land near the city limits of Warren, Ohio, on which will be constructed a $3,000,000 silica refractories manufacturing plant.

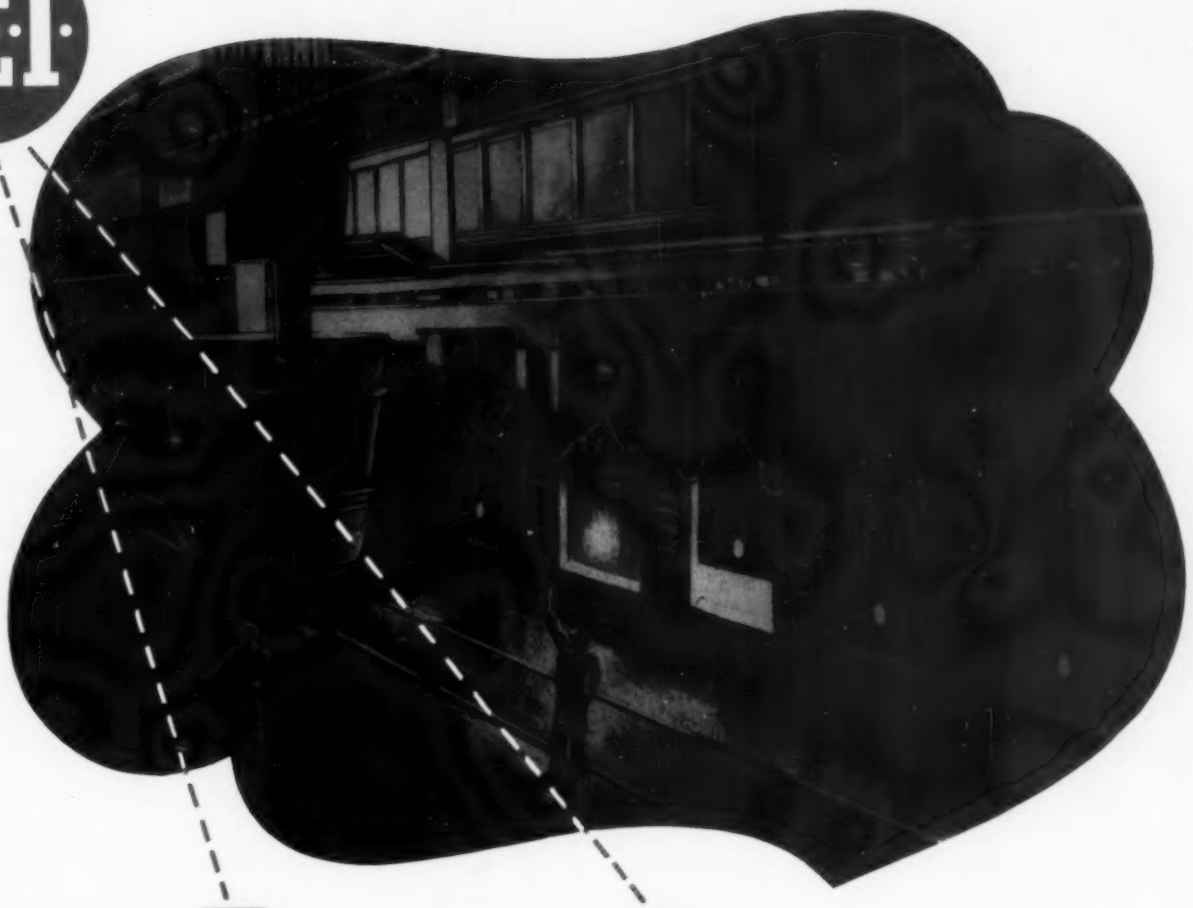
Plans for the Warren plant are a part of General Refractories broad expansion program which it has been announced will cost upwards of $12,000,000.

The new facility, which will contain 200,000 sq ft, will be located north of Warren's city limits, off Mahoning Road. The land has been cleared and a small creek crossing the property has been diverted in preparation for immediate construction.

The plant will be equipped with the latest screening, grinding and pressing machinery as well as with scientifically controlled oil burning tunnel kilns—each 600 ft long—in which the refractories are fired. A 1200-ft railroad siding will also be built to connect with the Baltimore & Ohio railroad whose lines run adjacent to the plant site. Raw materials will come from company-owned mining properties situated 18 miles northwest of Warren, near Garrettsville, Ohio.

Stockholders of the General Refractories Co. voted at the annual meeting to increase the authorized indebtedness of the company from $9,000,000

F·E·I·



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Furnace Engineers, Inc. provides the latest advancements in Open Hearth Furnaces that insure top performance. Our staff includes men with up to 30 years or more experience . . . specialists in the design, construction and operation of all types of industrial furnaces.

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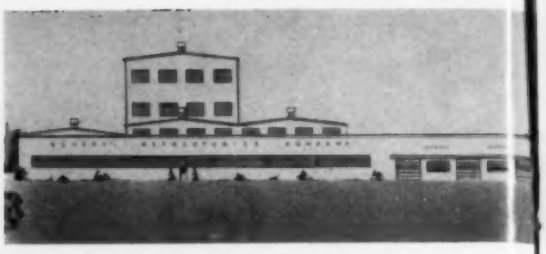
Write for descriptive folder on RODINE Pickling Acid Inhibitors.



Architect's drawing of the new Warren, Ohio, works to be constructed by General Refractories Co. during 1951. The plant, which is being built at a cost of $3,000,000, will contain latest grinding and pressing machinery and continuous tunnel kilns used in the manufacture of silica refractories.

to $15,000,000 to defray part of the cost of new facilities which the company will construct in its $12,000,000 expansion program.

Because of the increase in steel capacity which of necessity required an increase in the capacity of the refractory industry, it was deemed advisable to increase the authorized indebtedness of the company at this time. The additional borrowing will increase the company's outstanding indebtedness from $5,600,000 to $11,600,000. During the past ten years approximately 50 to 70 per cent of General Refractories output had been sold to the steel industry.

CHILEAN FIRM BUYS ACID-PROOF CEMENT

▲ Sauereisen Cements Co., Pittsburgh, Pa. has just completed a shipment of eight carloads of acid-proof cement to the Chilean Exploration Co., located at Antofagasta, Chile, South America. This is one of the largest single orders placed in recent months.

CONTROL COMPANY HAS NEW ADDRESS

▲ Mechanical Air Controls has announced the occupancy of their new building at 15311 West Eleven Mile Road, Royal Oak, Detroit, Mich.

CRUCIBLE TO RELINE MIDLAND FURNACE

▲ Crucible Steel Co. of America announced that one of its two blast furnaces in the Midland, Pa., works will be shut down around July 1 for re-lining and improvements.

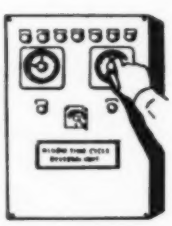
R. S. Poister, vice president in

The Bloom Time-Cycle Reversal Unit

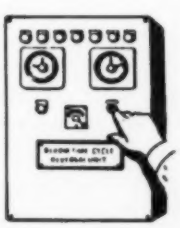
This Compact Factory-Wired Unit

Keeps Open-Hearth Furnaces "Regular"

The field connections are easily and simply made—no complicated wiring is required.



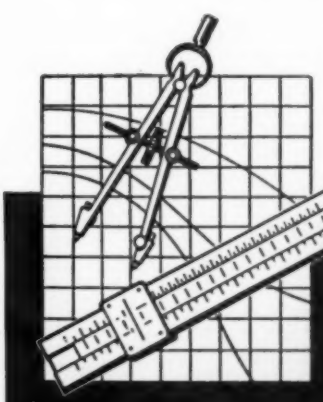
The desired period of firing is readily set up for each end independently, and is maintained until changed by the operator.



In case reversal is desired ahead of schedule, the operator merely pushes the reversal button. After reversal, furnace returns to original timing.

Only a few field connections are needed to install the Bloom Time-Cycle Reversal Unit for open-hearth furnaces, regenerative soaking pits, etc. The compact, factory-wired, dust-proof cabinet shown above contains all the controls, relays, timing devices and other instruments required to perform, in correct sequence, the operations needed for reversing the furnace on a predetermined time cycle. However, the furnace is at all times subject to the control of the operator; the timing can be readily altered, or a quick reversal ahead of schedule easily effected, if desired.

With this system, the average furnace can be completely reversed in nine to ten seconds. This means greater production, longer checker life, greater fuel economy.



BLOOM
ENGINEERING CO., INC.
857 W. North Avenue Pittsburgh 33, Pa.

charge of operations, said the blast furnace shutdown will result in reduced ingot production during the third quarter of the year. Full blast furnace operations will be resumed as quickly as possible.

It was reported that construction for a third blast furnace in Midland works is under way, as part of the national defense expansion program of Crucible announced recently.

FAIRLESS BILLET MILLS UNDER CONSTRUCTION

▲ The United Engineering and Foundry Co., Pittsburgh, Pa., announced the award of a contract from United States Steel Co. for a 30-in. six-stand continuous vertical and horizontal billet mill and a 21-in. four-stand continuous vertical and horizontal billet mill. These are for the new Fairless works of the company located near Morrisville, Pa.

Both mills will produce billets, rounds and slabs, the 30-in. mill rolling the larger sizes and the 21-in. mill rolling the product of the larger mill into smaller sizes as required.

The capacity of the installation is estimated to be about 3000 tons per eight-hour turn.

In addition to the two mills, the order includes tables, transfers, shearing and other equipment. The mills are to be completed in 1952.

GRANITE CITY BUYS KOPPERS COKE OVENS

▲ Granite City Steel Co. has awarded Koppers Co., Inc., a contract for the design and construction of a new battery of 27 chemical-recovery coke ovens at its Granite City, Ill., plant.

The new battery of 27 Koppers-Becker underjet coke ovens will be capable of carbonizing 1830 net tons of coal per day. Included in the contract are alterations and additions to the coal chemical, benzol, and coal handling equipment at the Granite City coke plant, to accommodate the increased production from the new battery.

Granite City Steel purchased the existing 49-oven coke plant and its two adjacent blast furnaces from Koppers in February, 1951, as part of the steel company's expansion program. The former Koppers plant is contiguous to the main Granite City Steel installation.

SALEM TO BUILD J&L HEATING FURNACES

▲ The two-zone reheating furnace for the Jones & Laughlin Steel Corp.'s new bar mill at the South Side works in Pittsburgh, Pa., will be built by Salem Engineering division of Salem-Brosius, Inc.

The furnace will be equipped to burn heavy oil or coke oven gas. Rated capacity will be 90 tons per hour. Inside furnace width will be 33 ft, with an effective hearth length of 60 ft.

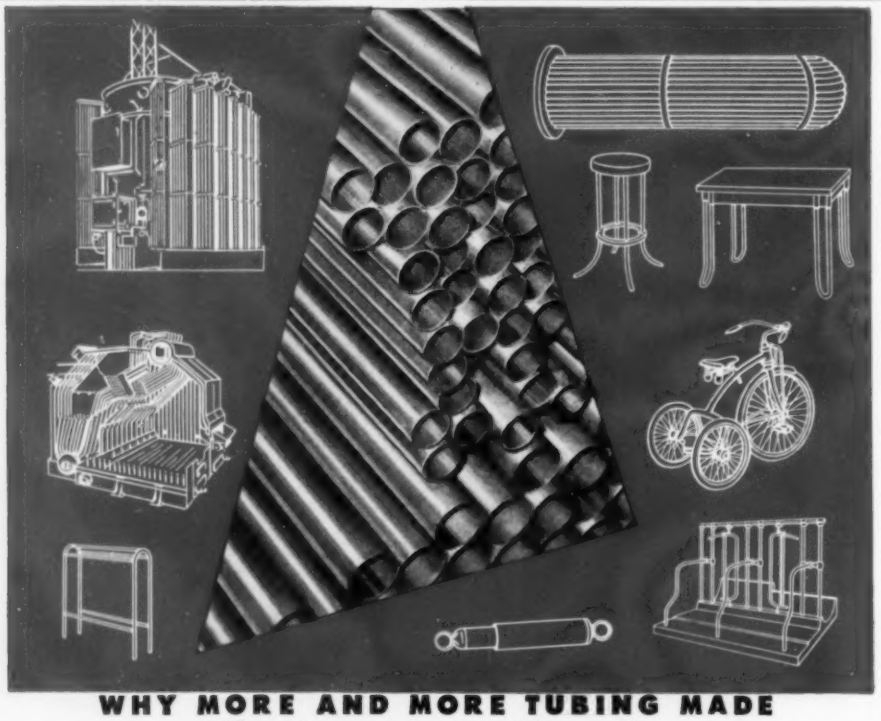
Erection is expected to start in mid-August as part of the J & L expansion program.

ORE FREIGHTER SETS NEW CARGO RECORD

▲ A new Great Lakes cargo record of 19,233 gross tons was set by the S. S. Wilfred Sykes, ore freighter of the Inland Steel Co., on a recent trip. The Sykes, on its fifth trip of the current season, arrived at its home port, Indiana Harbor, Ind., on May 9.

The ore carrier broke its own record of 18,929 tons set September 2–7, 1951, on the same run. The previous record was 18,725 tons set in 1947 by the steamer B. F. Fairless of Pittsburgh Steamship Co.

At the same time the Philip D. Block of the Inland fleet arrived at Inland Harbor on May 7 with a cargo of 14,900 gross tons of ore from its first trip since its between-season lengthening. The vessel had been stretched during the winter lay-up by



WHY MORE AND MORE TUBING MADE
"The Yoder Way"
GOES INTO THINGS DESIGNED TO STAY

Since Yoder in 1939 introduced their first electric-weld tube mills, high quality tubing at low cost has become available in quantities heretofore undreamed of.

The relatively low first cost of these mills, compactness, simplicity of operation and high production, virtually created a new industry, specializing in making fine tubing and making fine things from tubing.

Thousands of manufacturers of automotive equipment, household appliances, home and business furniture, farm equipment, bicycles, garden tools, boiler tubes, electric conduit, etc., have found in this tubing a ready means of making their products lighter and more attractive in appearance, yet stronger and longer lasting.

As a result, the demand for tubing has increased faster than the supply, so that tube-making "the Yoder way" today, more than ever, offers attractive rewards to private enterprise.

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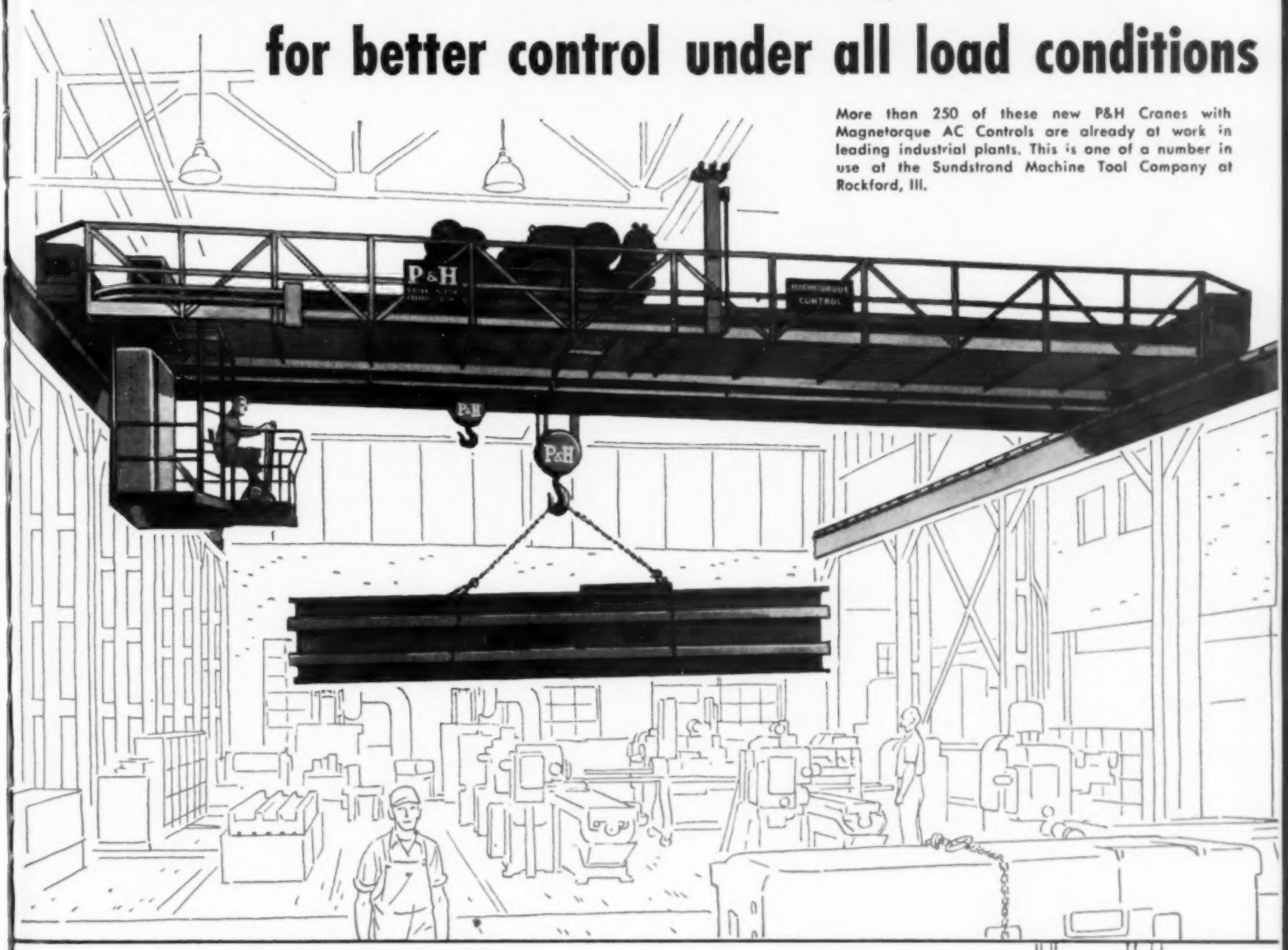
ENGINEERING YODER MANUFACTURING

P&H OVERHEAD CRANES

MAGNETORQUE*

for better control under all load conditions



More than 250 of these new P&H Cranes with Magnetorque AC Controls are already at work in leading industrial plants. This is one of a number in use at the Sundstrand Machine Tool Company at Rockford, Ill.

MAGNETORQUE means smoother, jerk-free handling . . . the ability to hover a load and then lower it with almost imperceptible motion. For accurate placement of heavy assemblies, it saves crane time — protects you against damage.

It means complete change of pace whereever you want it — under full load — or no-load conditions.

It means the end of the old mechanical load brakes and all their maintenance headaches. Magnetorque gives you all this with the convenience of AC power.

P&H Overhead Cranes serve you best when they have *all* the genuine P&H components — controls, motors, switches. P&H *balanced design* assures most efficient operation.

OVER 17,000 P&H CRANES SERVE AMERICAN INDUSTRY... FAR MORE THAN ANY OTHER

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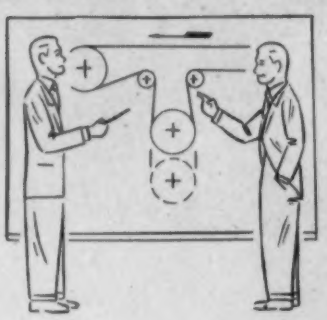
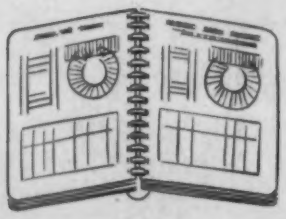
SOUND ENGINEERING PRACTICE





● The conveyer system which does the best possible job is the system that was specifically designed to meet the requirements of that job. There is quite a lot of know-how in designing and fabricating conveying equipment, and no place for trial and error methods. It just costs too much to learn the hard way—by actual application—that equipment is too light, poorly constructed, or just improperly designed to do the work.

Mathews Conveyer Systems are made up of Power and Gravity Conveyers and special conveying machinery that is built on sound engineering principles—equipment that is designed to do a specific job well. That's why, when you are buying conveyers, whatever the application might be, you can be sure about this: If it's Mathews equipment, it has to be right.

Engineering offices or sales agencies are located in principal cities in the United States and Canada.

MATHEWS CONVEYERS

GENERAL OFFICES . . . . . *Mathews Conveyer Company*
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PACIFIC COAST DIVISION . . *Mathews Conveyer Company West Coast*
SAN CARLOS, CALIFORNIA

CANADIAN DIVISION . . . . . *Mathews Conveyer Company, Ltd.*
PORT HOPE, ONTARIO

the addition of a 72-ft section amidship which was expected to add 1400 tons to its capacity. Its new record cargo exceeded expectations and was 2100 tons larger than its average cargo for the 1950 season.

NEW SILICA PLANT FOR DOWNINGTON, PA.

▲ Harbison-Walker Refractories Co. will build a new $3,500,000 silica plant at Downington, near Philadelphia, Pa. This plant will be in addition to the scheduled $22 million expansion program already announced by Harbison-Walker. It will be a duplicate of the Windham, Ohio plant the company will complete about the end of 1951.

Decision to build this new silica plant was based on the increased need for coke. The Downington plant will be used to produce materials for lining the industrial furnaces used in coke production. Downington was selected as the plant site because of its nearness to the new U. S. Steel Co. Fairless works and other nearby plants.

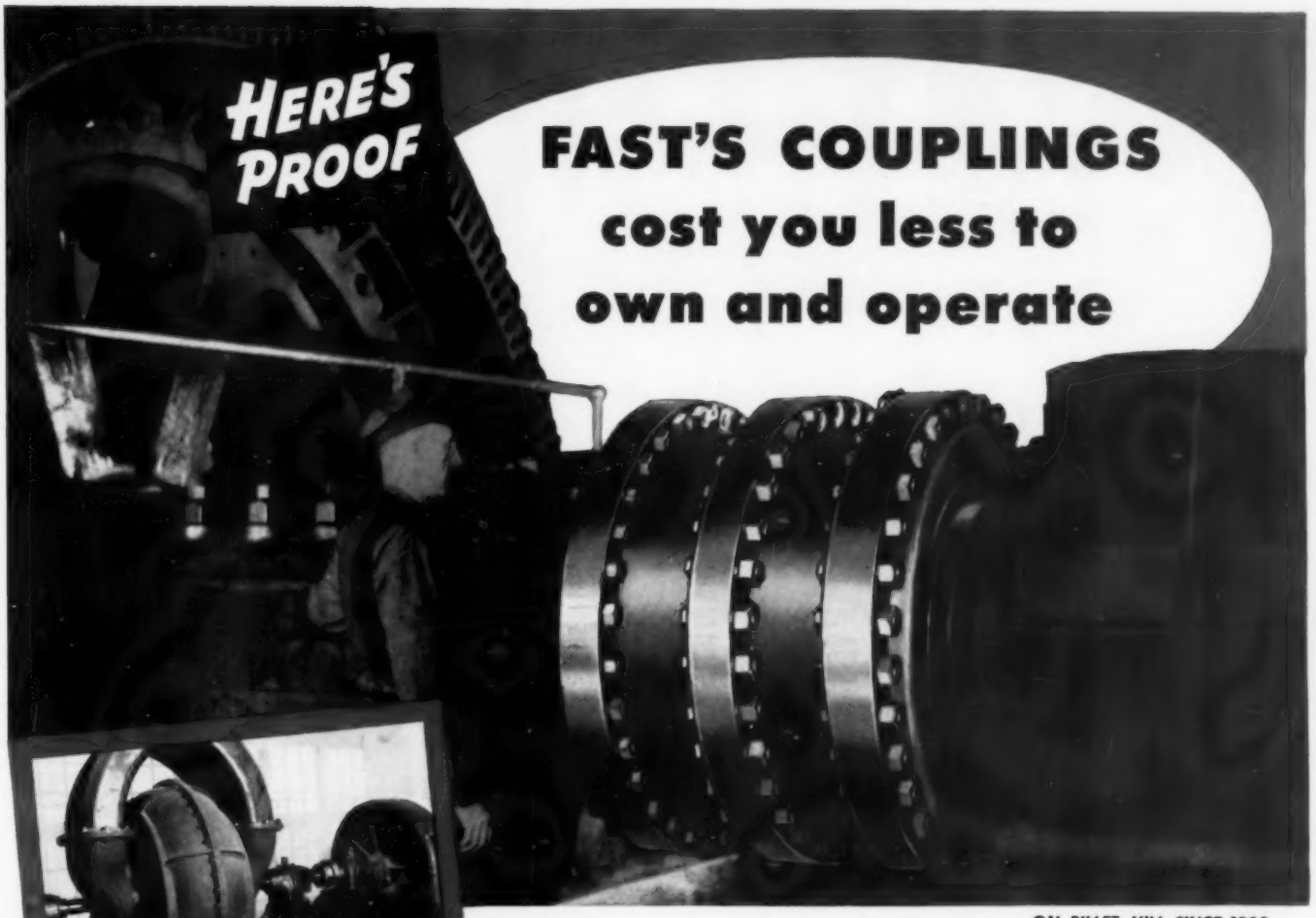
Mr. Garber also revealed that Harbison-Walker's new clay brick unit at Bessemer, Ala. will be in operation by July, permitting capacity at that plant to be doubled. A new tunnel kiln already in operation has increased production at the Fulton, Mo. works by 25 per cent.

Potential capacity of the Harbison-Walker magnesite plant at Cape May, N. J. is expected to be doubled July, as will production at Fairfield, Ala. by the end of 1951. Expansion which will add one-third to the present capacities at East Chicago, Ind. and Baltimore, Md. will be under way by the last quarter of this year.

ECA AWARDS CERTIFICATE TO UNITED ENGINEERING

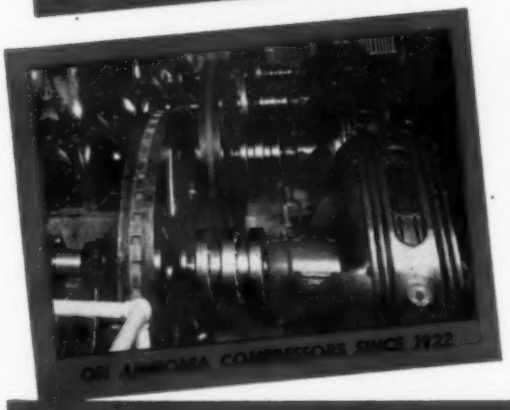
▲ The Economic Cooperation Administration, better known as the Marshall Plan, has awarded to the United Engineering and Foundry Co. of Pittsburgh, Pa., a Certificate of Cooperation for furnishing technical assistance to the peoples of the Marshall Plan countries to aid them in maintaining individual liberty, free institutions and peace.

Through the sponsorship of ECA, United has furnished the machinery as well as technical assistance for the



FAST'S COUPLINGS cost you less to own and operate

ON BILLET MILL SINCE 1923



Fast's Couplings cost you less per year because they normally outlast the equipment they connect. That means their reasonable cost can be spread out over 20 years or more . . . assuring low-cost service without excessive maintenance costs!

Fast's basic design is *foolproof!* Instead of a perishable oil seal, Fast's are the only couplings to use a *permanent* metal-to-metal closure. Oil is always maintained at a safe level . . . whether the coupling is running or standing still . . . and dirt cannot get in. Fast's Couplings are compact, yet large enough to stand up under punishing service for 20 years or more!

When you specify Fast's Couplings, you get Koppers' valuable engineering service. In many cases where a special coupling appears necessary, Koppers engineers can modify a standard Fast's and save you money! Get the facts on Fast's Couplings. Mail the coupon for your copy of Fast's *free* Catalog today!

Mail Coupon for FREE Catalog

KOPPERS CO., INC., Fast's Coupling Dept.,
216 Scott Street, Baltimore 3, Md.

Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.

Name.....

Company.....

Address.....

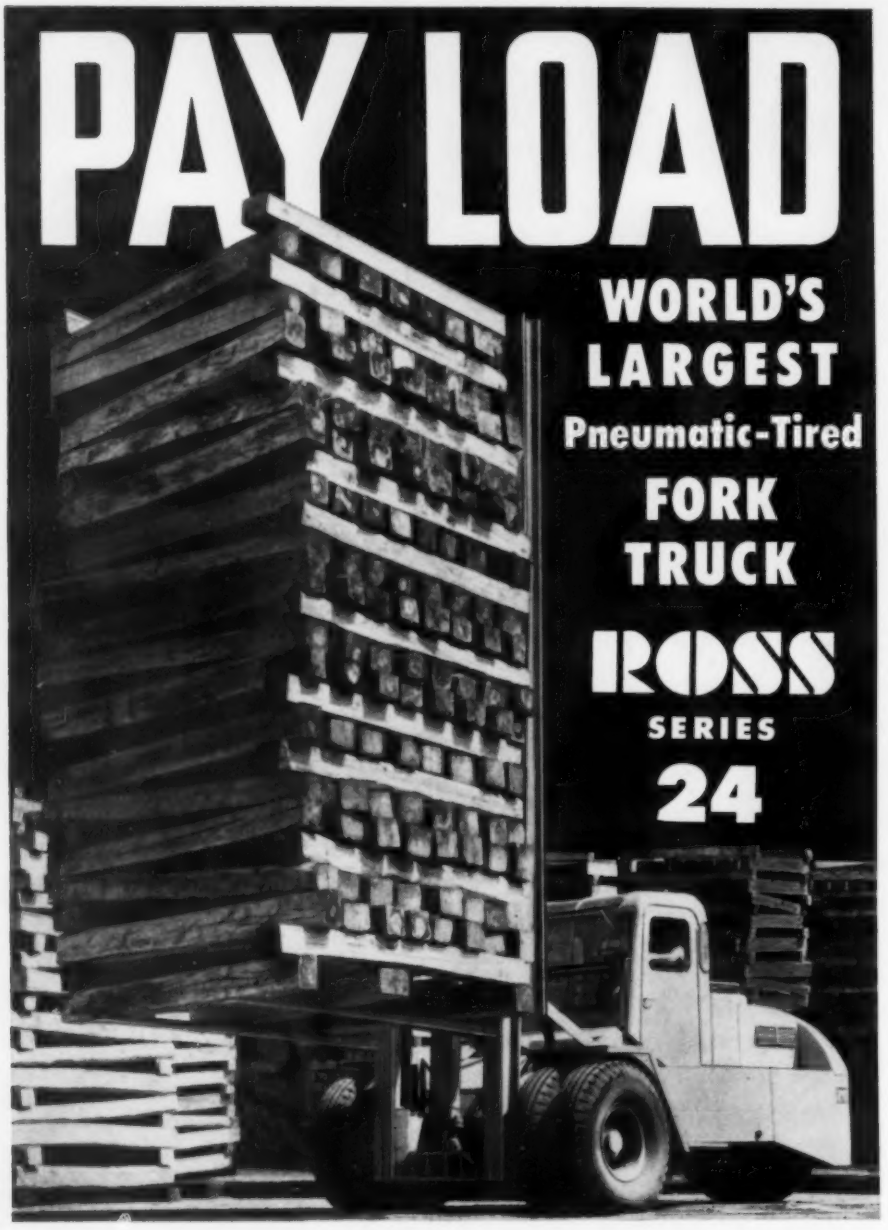
City.....Zone.....State.....

KOPPERS

FAST'S
THE ORIGINAL
GEAR-TYPE
Couplings

INDUSTRY'S STANDARD FOR 31 YEARS

PAY LOAD



HANDLES LOADS WEIGHING 26,000 LBS.-72″ WIDE

•

SPEEDS HANDLING OF BILLETS, BARS, IN-PROCESS AND FINISHED MATERIALS

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HUGE 14.00-20 TIRES, PLENTY OF WEIGHT ON DRIVING WHEELS-MINIMUM YARD SURFACING REQUIRED

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TAKES TOUGHEST OPERATING CONDITIONS IN STRIDE

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You'll want full details on this giant fork truck . . . designed to further speed mass handling of heavy materials and reduce costs even more. Write today.

Rely On ROSS

THE ROSS CARRIER COMPANY

Direct Factory Branches and Distributors Throughout the World

400 Miller St., Benton Harbor, Michigan, U.S.A.

majority of the post war steel mill installations in various countries in Europe as well as in England.

TIN PLATE EXPANSION PROGRAM STARTED AT J&L

▲ Construction is underway at the Aliquippa, Pa. works of Jones & Laughlin Steel Corp. on facilities for the expansion program of its tin plate department.

The project includes a coil cooling and temper mill building, roll shop, annealing building extension, battery charging station, and a cleaning building, designed and being constructed by Rust Engineering Co.

The coil cooling and temper mill building will be 350 ft long, 125 ft wide, of steel frame construction with corrugated asbestos siding, steel deck and built-up roof.

Plans call for these replacements and additions to existing facilities to be accomplished with as little interruption to production schedules as possible.

SCRAP COMMITTEE IS FORMED BY INSTITUTE

▲ Formation of a joint committee representing the nation's foundries, scrap dealers and steel mills to deal with the critical scrap problem was announced here today by Robert W. Wolcott, chairman, Lukens Steel Co., and chairman of the Committee on Iron and Steel Scrap of the American Iron and Steel Institute. The new committee is to be called the Mobilization Committee for Iron and Steel Scrap.

Members of the new Mobilization Committee on iron and steel scrap are as follows: Robert W. Wolcott, Lukens Steel Co.; F. H. Handfelder, Steel Foundry Society of America; H. S. Faust, Gray Iron Foundry Society; Herman D. Moskowitz and E. C. Barringer, Institute of Scrap Iron and Steel; Lowell D. Ryan, Malleable Founders Society; Max Kuniansky, Lynchburg Foundry Co.; F. Hermit Donaldson, Steel Founders Society of America; Charles H. Lipsett, Waste Trade Journal; J. D. Sloan, The Youngstown Sheet and Tube Co.; P. S. Killian, Bethlehem Steel Co.; L. D. Greene, American Iron and Steel Institute; F. J. Lasky, Republic Steel Corp.; W. W. MacMillen, National Malleable & Steel

"Tycol Apreslube cuts bearing failure... keeps production going at top speed"

That's correct! Tycol Apreslubes are extreme pressure lubricants that stand up under severe heat and moisture conditions, under tremendous loads. They inhibit rusting, and are highly stable.

Tycol Apreslube means lower lubrication costs . . . longer equipment service life . . . and positive protection against excessive gear and bearing wear.

For complete data, call or wire your nearest Tide Water Associated office.

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SEND FOR A FREE COPY OF "TIDE WATER ASSOCIATED LUBRICANIA"

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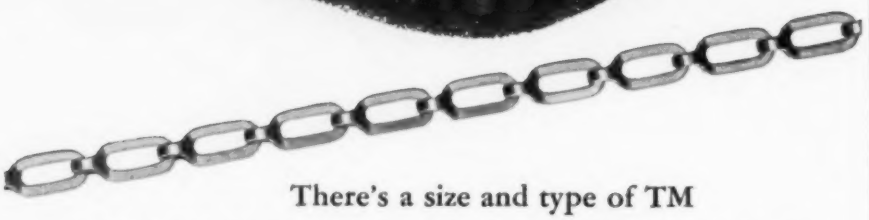
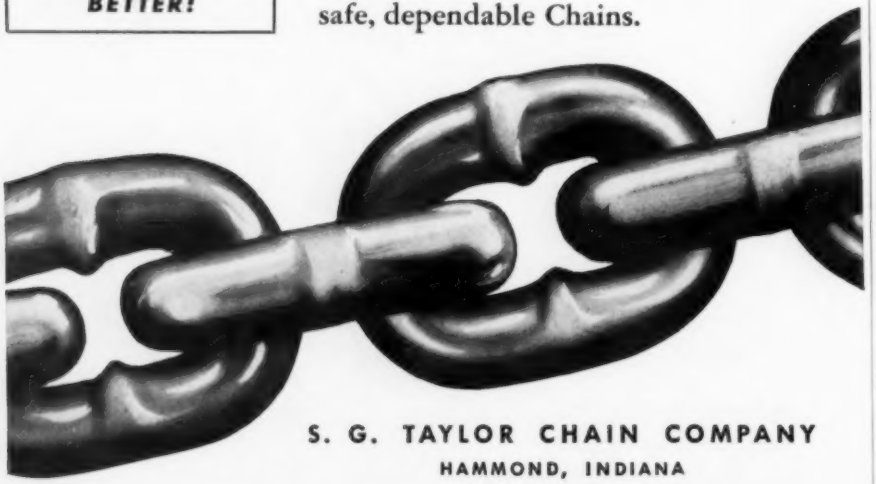
.. of Safe Dependable Chain for Every Job!



There's a size and type of TM Chain to fit each of your requirements. Choose from Proof Coil, BBB, Steel Loading, Hi-Test, Alloy Steel, Dredge Iron, Conveyor, Machine, Coil, Side, Truck, Passing Link, Well, Anti-Spreader, Trace, Furnace, Champion Weldless, Jack (single or double), Pump or Sash Chain. See your mill supply distributor or send coupon today for details on any of these safe, dependable Chains.

Each does a definite job— BETTER!



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Please rush details on _____ chain.

Name _____

Address _____

TAYLOR MADE
A GREAT NAME IN *Chain* SINCE 1873

Casting Co.; C. A. Ilgenfritz, United States Steel Co.

CONSTRUCTION STARTED ON ST. LOUIS OVENS

▲Construction has started in St. Louis on 40 new coke ovens at the merchant coke plant of the Great Lakes Carbon Corp. The ovens, which are of the latest design embodying all modern developments in coke oven construction, will increase the capacity of the plant by about 75 per cent when they start operation in the summer of 1952.

YODER CO. OPENS PITTSBURGH OFFICE

▲Yoder Co., Cleveland, Ohio, manufacturers of cold-roll-forming, slitting and tube mill machinery, announce the opening of a Pittsburgh sales office, in charge of Joseph M. Hill, formerly of their Cleveland office. The new office is located in the First National Bank Building, Pittsburgh, Pa.

CERAMIC SOURCES FOUND IN TEXAS

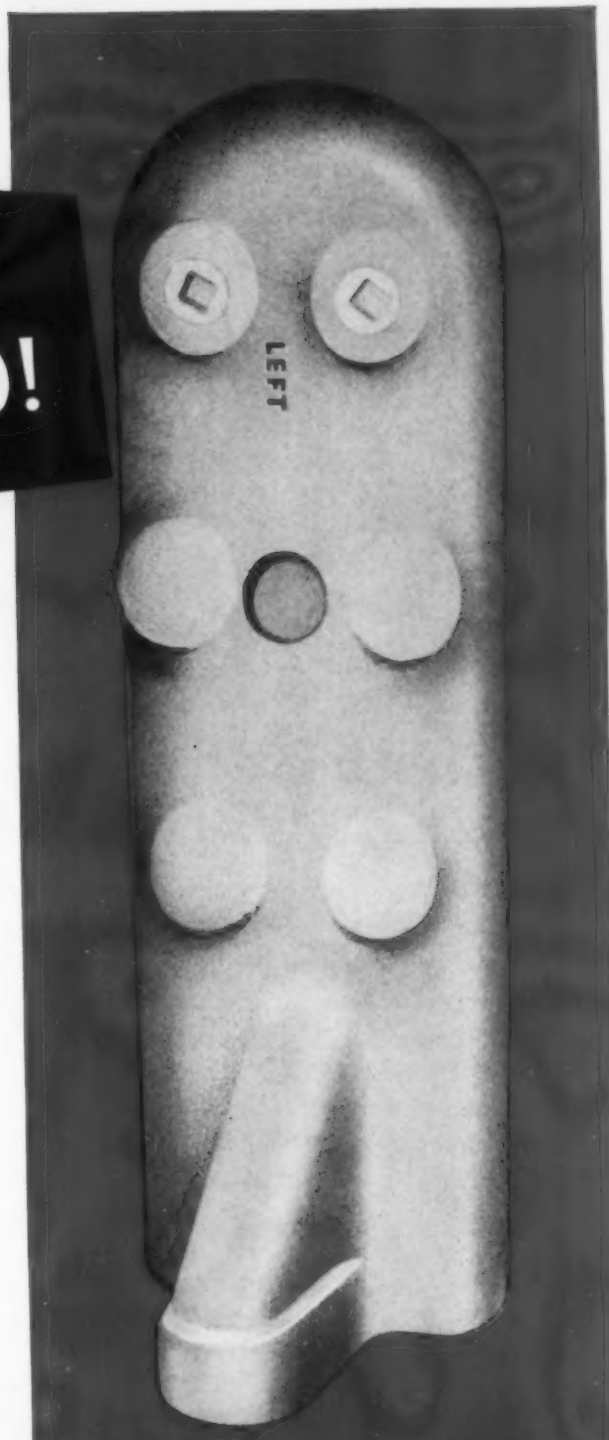
▲ Discovery of raw material sources of sufficient magnitude to make San Antonio, Tex., a ceramic manufacturing center, as well as to permit development of a sizable mineral processing industry in South Texas, has been reported by Southwest Research Institute.

These facts came to light upon completion of a six-month preliminary survey of the area's ceramic production potentials by the institute's mineralogy department. Authorized by a city government bureau, the survey was conducted by Mr. John Funnell, ceramic engineer and economic geologist.

"The ceramic industry requires readily available sources of kaolin, ball clays, talc, flint, feldspar and other materials. All were found in abundance in the area," Mr. Funnell said. "In addition, it requires an adequate source of low cost fuel for which the ample supply of natural gas in the region is satisfactory."

Among facts uncovered by the ceramic engineer were the existence of substantial quantities of kaolin, plastic clays, talc and feldspar in the

THIS CASTING SAVED $12,000.00!



Why an Electrode Holder, redesigned by National Bearing Division, lasted over 73 times longer

A large Midwest plant was getting 5 days service from furnace electrode holders . . . before a trial order was placed with National Bearing Division. This plant saved dollars—*right from the start.* A special copper alloy permitted sound, dense castings at no sacrifice in electrical conductivity. Result? *30 days service—instead of 5—before replacement.*

On the next order, National Bearing Division engineers submitted a new design for the clamp—for greater strength and resistance to cracking. The redesigned electrode holders are still in use—after a year of trouble-free operation! They've saved $12,000.00 on replacement costs and furnace maintenance.

Better, longer-lasting non-ferrous parts can save money in your plant or product . . .

National Bearing Division has complete facilities for finding practical, economical solutions to non-ferrous bearing and casting problems. Investigate these complete facilities—whether your problem requires designed engineering service, or production of non-ferrous parts to your own specifications.

If you design, specify or purchase . . . *This catalog will interest you*

Find out how complete facilities for Research, Engineering and Production can reduce costs of non-ferrous parts in your plant or product. Write for a free copy of this catalog.

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AMERICAN Brake Shoe COMPANY

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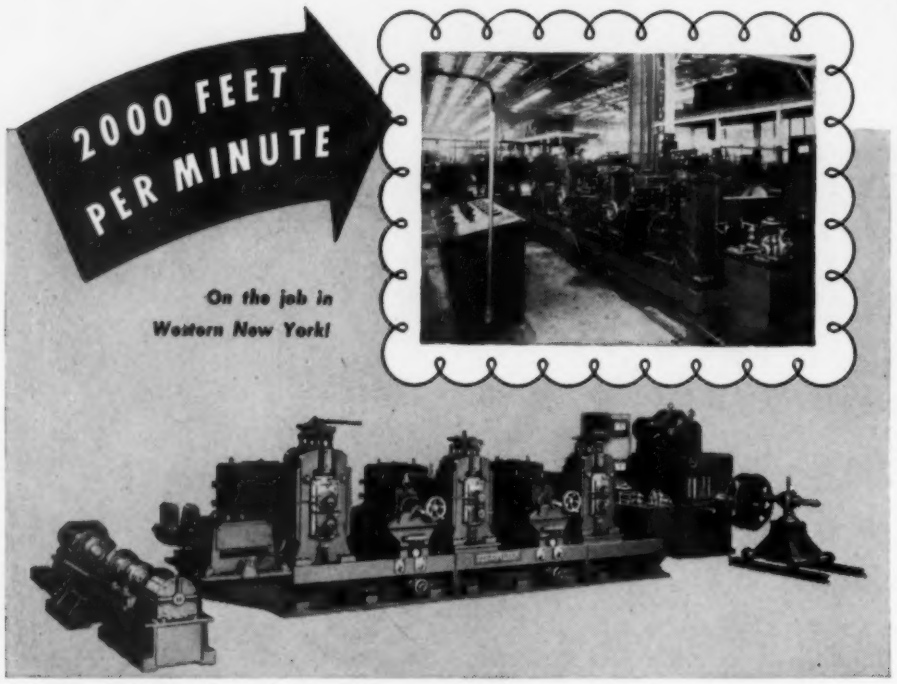
PLANTS IN: ST LOUIS, MO • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL.



TORRINGTON'S NEW, HIGH SPEED FLAT WIRE MILL

- ★ Individual motor drive for each flattener stand!
- ★ Automatic adjustable constant tension on pay-off and winder!
- ★ All rolls in pre-loaded precision type bearings!
- ★ Driven edging rolls after each stand except finishing stand!
- ★ Magnetic gauges for continuous gauging of wire thickness and width!
- ★ External coolant system for work and rolls!
- ★ Internal cooling on flattening rolls!
- ★ All gearing totally enclosed and running in oil!

This tandem flat wire rolling and edging equipment produces flat, square or rectangular shaped wire from round rod or wire. In Torrington flat wire mills, the metal passes successively from the pay-off through breakdown rolls, grooved edging rolls and final finishing rolls onto a winder. Magnetic gauges measure the wire between finishing rolls and winder.

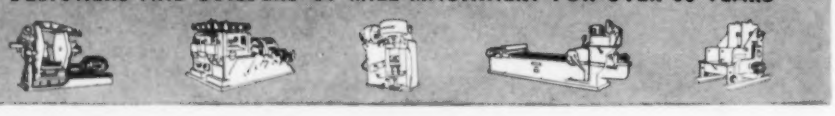
Precision production to thickness tolerances as exacting as .00025" and to .001" on the width is possible with Torrington Flat Wire Rolling and Edging Equipment. This unusually high degree of accuracy is the result of 60 years experience in the design and construction of auxiliary mill equipment.

Call or write Torrington today for more information and name of nearest Torrington representative.

The TORRINGTON

MANUFACTURING COMPANY TORRINGTON, CONNECTICUT

DESIGNERS AND BUILDERS OF MILL MACHINERY FOR OVER 60 YEARS



immediate San Antonio area. Laboratory tests showed the kaolin compared favorably with Georgia kaolins imported into Texas.

"As much as thirty-two per cent of kaolin has been washed from the sandy raw material in which it occurs immediately east of San Antonio," Mr. Funnell reported. "Of excellent quality, this kaolin has been incorporated in tile and white ware bodies in the laboratory with good results."

The ceramic engineer continued that a clay found a few miles south of the city had been treated to produce a quality clay burning to a near white color at 2000 F.

"These clays have fusion points in the range of 2700 to 3000 F and, in addition to their use in the production of refractory bodies, saggers and wad clays, they can be utilized as substitutes for a portion of the ball clays now being imported into this region by ceramic plants."

SALEM BUILDING UNIT FOR LONE STAR STEEL

▲ Salem Engineering division of Salem-Brosius, Inc., will build an 80-ton per hour, triple-fired reheating furnace for the Lone Star Steel Co.'s new plant at Dallas, Tex.

Designed to burn natural gas, the Salem slab furnace will be fully equipped with the latest in automatic controls. Erection is scheduled for the latter part of 1951.

CAR-TYPE FURNACE IS BEING DESIGNED

▲ A car-type furnace is being designed and will be built at the Chicago, Ill., plant of the Chicago Bridge and Iron Co., according to Rust Furnace Co., the designer-constructor.

The new furnace will be used primarily to heat plates before pressing, and occasionally to stress relieve small assembly pieces. It will be fired by natural gas.

MANUFACTURERS' AGENT MOVES IN PITTSBURGH

▲ P. C. McKenzie Co. has moved to 3829 Willow Ave., Castle Shannon, Pittsburgh 34, Pa. The McKenzie Co. represents Fluor Corp, Ltd., Griscom-Russell Co., and Le Roi Co.

For efficiency and low maintenance cost specify Salem Circular Soaking Pits

You save when you operate a Salem soaking pit for a number of very sound reasons. First of all, you'll find it costs less to maintain than any ingot heating furnace designed by anybody. As a matter of fact, the dome-shaped cover on the Salem pit has a normal life span of five years without repair —fully five times the life of most covers. Second, you enjoy virtually wasteless uniformity of heating due to Salem's unique circular design. Operators report highly efficient operation, low scale loss. Third, you'll experience the advantage of the most rapid ingot heating rate in the world to boost production when you need it. For higher production at low cost, you should have Salem Soaking Pits. Write to us.

SALEM ENGINEERING DIVISION,

Salem-Brosius, Inc. Salem, Ohio
Affiliates: Brosius Division, Pittsburgh 15, Pa.
Salem Engineering Co., Ltd., Milford nr. Derby, England; Salem Engineering (Canada) Ltd., Toronto, Canada

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STAND-BY POWER
for
UTILITIES

Long Life at Reduced Cost

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NICKEL CADMIUM BATTERIES

The unique physical and electrical characteristics of NICAD batteries provide reliable, low-maintenance power for switchgear operation, supervisory control and emergency lighting on the typical sub-station installation above.

Compact NICAD cells consistently deliver high currents required for switch operation with minimum voltage drop, at either regular or intermittent intervals and are unaffected by long periods of idleness.

SAVE MORE MAN HOURS
FOR A LONGER TIME
with
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Negligible Water Consumption
Eliminates Gravity Records
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MADE EXCLUSIVELY IN THE U.S.A.

BATTERY FIRM'S PLAN AIDS BATTERY USERS

▲ Mr. M. W. Heinritz, vice president, Gould-National Batteries, Inc., announced Gould's new "Plus-Performance Plan." The plan is devised to help industrial battery users get the maximum power and life from their batteries for extra defense production during lead cut-backs.

Said Mr. Heinritz, "With the issuance of the various Government shortage materials orders, including the recent NPA lead conservation order M-38, effective April 1, 1951, it becomes increasingly evident that it is necessary for all industry to make those materials which we now have, last longer and produce more.

"Gould has anticipated a schedule of this nature and has been working for some months on a program geared to conserve essential battery power.

"The Gould 'Plus-Performance Plan,' outlined below, is designed to help users get more production and greater performance from their storage battery equipment.

"The 'Plus-Performance Plan' consists of an integrated conservation program based on applicable charts, manuals, and articles pertaining to particular users' problems.

"Users need merely advise us of their interest and we will forward, without obligation, that material which we feel will be of most help in their particular case."

The material contained in the Gould "Plus-Performance Plan" is available, without cost, to all users of batteries for industrial trucks, mining equipment, railroad signaling and communications, telephone systems, utility service, and emergency lighting and alarm systems.

The plan operates as follows: the battery user simply addresses a request to Gould-National Batteries, Inc., Trenton 7, N. J., stating two things, (1) the kind of battery service in which he is interested (industrial truck, telephone, etc.) and (2) the points on which he desires information. Upon receipt of the request special individualized portfolios will be made up covering the technical information desired in the indicated field of battery use. Included in the

NEW FOLLANSBEE WAREHOUSE IS OPENED

Meeting in front of Follansbee Steel Corp.'s new Pittsburgh warehouse are, left to right, Mark C. Craven, manager of the Pittsburgh warehouse; R. K. Follansbee, vice president in charge of sales; and J. H. Dowling, general manager of Follansbee metal warehouses. The South Side building covers more than two acres, representing an increase of more than 300 per cent over storage area in the firm's former downtown warehouse. Storage capacity has been increased by 600 per cent.

WILSON

HIGH CONVECTION ANNEALING FURNACES

These furnaces are installed at the Thomas Steel Company, Warren, Ohio, to anneal the steel coils rolled on their new 3-stand tandem cold mill.

THIS unique installation of Wilson radiant convector bell type furnaces is designed for multiple stacking of small coils on a 90-inch diameter base, to use convectors in each stack and apply the Wilson convection system to all stacks with one central recirculating fan.

Lee Wilson

ENGINEERED AND CONSTRUCTED BY

ENGINEERING Co., Inc.

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BELL TYPE FURNACES • RADIANT TUBE HEATING • ANNEALING PROCESSES

Quick-As-Wink
AIR AND HYDRAULIC
Control Valves

No. 1551-N3
¾ Inch Neutral
Position 3-Way
Air Valve

HAND OPERATED Air Valves

Thousands of Uses Throughout Industry

● Universally used and endorsed. Valving mechanism has stainless steel body and push-pull rods, brass sleeves, self-sealing U-packers and many other refinements, all fully enclosed against dirt, assuring long efficient trouble-free operation. No metal to metal seating. ⅜″ to 1½″ sizes, 3-way and 4-way, neutral position and regular actions. Pipe header mounting plates furnished if desired. *Write for full details.*

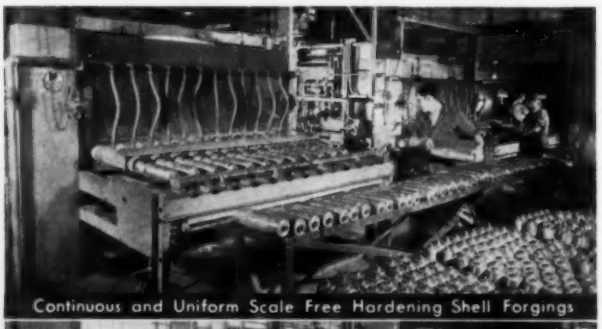
THE HIGHER THE PRESSURE THE TIGHTER THE SEAL

Quick-As-Wink
AIR AND HYDRAULIC
Control Valves

Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

Mfd. by C. B. HUNT & SON, INC., 1988 East Pershing St., Salem, Ohio

EF FURNACES *for* **shell forgings, shell cases, aircraft, tank parts, and other defense products**



Continuous and Uniform Scale Free Hardening Shell Forgings

Clean Annealing and Stress Relieving Cartridge Cases

● Let EF engineers, with their wide experience on hundreds of shell, aircraft, tank, gun, bomb, cartridge clip, metal powder, ammunition, and other projects, help you with your defense production furnace problems—we already have the drawings.

Gas-Fired, Oil-Fired EF *and Electric Furnaces*
for any Process, Product or Production
THE ELECTRIC FURNACE CO.
WILSON ST. at PENNA. R. R. *Salem - Ohio*

portfolio may be reprints of engineering articles from leading trade magazines, instruction manuals, specification data with discharge curves, bulletins covering battery construction, charging charts, sets of sample record cards, etc. The prepared folio, which constitutes a reference file on the subject covered, will be promptly forwarded, without obligation, to the inquirer. Should specific questions be asked concerning special problems, Gould's engineering staff will prepare and forward an individualized study and recommendations. Finally, a request on a special field problem will bring Gould's field engineers to inspect the batteries themselves without obligation.

YORK ENGINEERING MOVES HEADQUARTERS

▲ York Engineering and Construction Co., Pittsburgh, Pa., has just moved its offices and engineering departments to larger quarters at 951 Penn Avenue, according to an announcement by James MacGregor, president. The company occupies the entire fifth floor of the building and has acquired 60 per cent additional floor space to house the additional personnel required by the large increase in business over the past few years.

York Engineering and Construction Co. are general engineering contractors who offer a complete service in the design of buildings, foundations, and equipment for industrial plants, including project coordination and control. They have recently completed several large projects of this nature for steel mills located in various parts of the country.

ANNOUNCE OFFICERS OF SALEM-BROSIUS, INC.

▲ Announcement of officers of the new corporation, Salem-Brosius, Inc. was made May 29. Salem-Brosius, Inc. is the outgrowth of the purchase of Salem Engineering Co. of Salem, Ohio by the Edgar E. Brosius Co. of Pittsburgh and the resultant merger of the two companies. Ward A. Wickwire, formerly president of Brosius remains in the same capacity with the new organization and Ward A. Wickwire, Jr. has become executive vice president. Other officers are:

Frank E. Myers, vice president in charge of operations, H. W. Eddy, vice president and controller and Carl J. Westling, chief engineer. Sam Keener, former president of Salem Engineering Co. has announced his retirement from any participation in the management of the merged companies. Salem-Brosius, Inc. will make its headquarters at this time at the Brosius Sharpsburg plant near Pittsburgh, Pa. The Brosius division of the new company will continue to manufacture mechanical equipment for blast furnaces and steel mills, and the Salem Engineering division will continue to design and construct all types of large industrial heating furnaces.

YALE & TOWNE SELLS ITS SCALE DIVISION

▲ The sale of its industrial scale business to Detecto Scales, Inc., Brooklyn, New York, was announced by the Philadelphia division of Yale & Towne Manufacturing Co. Effective on June 1, 1951, the transaction involved scale patents, equipment, parts and inventory, but none of the Yale trade marks, except "KRON."

The space, machine hours, and manpower release by the sale of the scale business will be used to relieve the pressure of the defense requirements for Yale industrial trucks and hoists.

L&N MOVES ITS BOSTON, MASS., OFFICE

▲ The Boston office of Leeds & Northrup Co., manufacturers of electrical measuring instruments, automatic controls, and heat-treating furnaces, has been moved to 430 Lexington Avenue, Auburndale (Boston 66), Mass. This new, larger office affords better facilities for providing engineering information and service to manufacturers, researchers, and educational institutions in the Boston area.

RAYTHEON MOVES NEW YORK OFFICE

▲ Raytheon Manufacturing Co. of Waltham, Mass. announces the transfer of its New York and International Sales Offices to 19 Rector Street, New York 6, N. Y.

Quick-As-Wink AIR AND HYDRAULIC Control Valves

No. HH-551-N4 — ¾" 4-Way Neutral Position Hydraulic Valve

LEVER OPERATED Hydraulic Valve

For water or oil hydraulic systems to 5000 p. s. i.

● Unsurpassed for efficient trouble-free service controlling double acting hydraulic cylinders and other important high pressure hydraulic circuits. Positive, fast acting. All parts are in pressure balance, eliminating any tendency to creep or crawl. Machined steel housing, chrome plated and polished stainless steel plungers. Self sealing U-packers. Metal valving rings take the impingement of the liquid, preventing wear on the packings. ½" to 1½" sizes. Available also in pilot operated designs up to 4". *Write for full details.*

THE HIGHER THE PRESSURE — THE TIGHTER THE SEAL

Quick-As-Wink AIR AND HYDRAULIC **Control Valves**

Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

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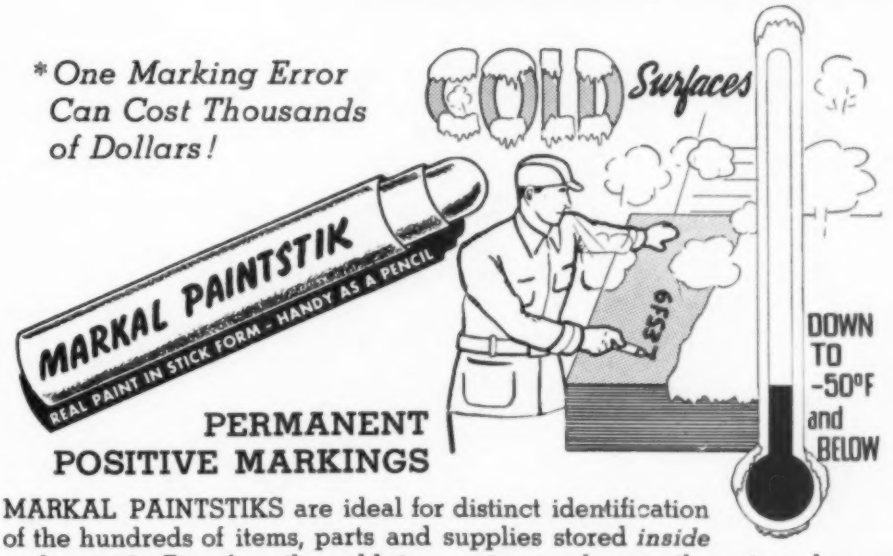
STOP CONFUSION and LOSSES* with Good Identification!

*One Marking Error Can Cost Thousands of Dollars!



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MARKAL PAINTSTIKS are ideal for distinct identification of the hundreds of items, parts and supplies stored *inside* and *outside*. Fine for oily, cold, icy, rusty, rough, smooth, wet or dry surfaces—metal, wood or any other.

Weather-Proof • Fade-Proof

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53 BLAST FURNACES LINED WITH NATIONAL CARBON,

TRADE-MARK

HAVE AVERAGED 1,000,000 TONS EACH

– *and still going strong!*

● National Carbon Company has now equipped 53 furnaces with carbon-block linings. 27 of these linings have produced over 1,000,000 tons of iron apiece at this writing. 10 of these linings have produced 1,500,000 tons. One lining has topped 1,900,000 tons. All linings are still going strong. We can think of no stronger proof of the value of "National" carbon for lining blast furnaces.

The term "National" is a registered trade-mark of
NATIONAL CARBON COMPANY
a Division of
UNION CARBIDE AND CARBON CORPORATION
30 East 42nd Street, New York 17, N. Y.
District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco
In Canada: National Carbon Limited, Toronto 4

OTHER NATIONAL CARBON PRODUCTS

BLAST FURNACE LININGS • BRICK • CINDER NOTCH LINERS • CINDER NOTCH PLUGS • SKIMMER BLOCKS • SPLASH PLATES • RUNOUT TROUGH LINERS • MOLD PLUGS • TANK HEATERS

Personnel News...

A. P. Miller was elected vice president in charge of operations, for Newport Steel Co., Newport, Ky. Mr. Miller formerly was general superintendent of the Indiana Harbor, Ind., works of Inland Steel Co.

William H. Feathers, general superintendent of the Niagara Falls works of National Carbon Co., a Division of Union Carbide and Carbon Corp., has been awarded an Alfred P. Sloan Fellowship for executive development, at Massachusetts Institute of Technology. The Fellowship provides for an intensive one year program of study of the problems of business management, of industrial and human relations in industry and of the responsibilities of industry to national and international problems. He is being granted a leave of absence and upon completion of the program will return to National Carbon Co.

William S. DuBois has been named head of a newly established market research department at Harbison-Walker Refractories Co., Pittsburgh, Pa. Mr. Dubois was formerly senior market analyst for the Firestone Tire and Rubber Co. Among the functions of the new department will be the evaluation of customers' needs for new and existing types of refractories. When the need for a new product is established, the department will consider the means of developing it and of making it available in commercial quantities at prices the customer can afford to pay.

E. L. Casey was elected vice president in charge of manufacturing for E. W. Bliss Co., Canton, Ohio. Mr. Casey's previous associations include the Babcock and Wilcox Co., the California Shipbuilding Corp., Westinghouse Electric Corp., and the Atomic Energy Commission.

W. P. Getty was appointed to the position of assistant to vice president—operations, Jones & Laughlin Steel Corp., Pittsburgh, Pa. **C. M. Lichy** will succeed Mr. Getty as assistant general manager of raw materials and **C. E. Amos** has been appointed to the position of assistant to general manager of raw materials.

George C. Peters was named civil defense coordinator for Jones & Laughlin Steel Corp., Pittsburgh, Pa. Mr. Peters will work in close cooperation with the civil defense authorities and will coordinate civil defense activities among the various units of J & L.

J. Cameron Argetsinger tendered his resignation as vice president of Youngstown Sheet and Tube Co., Youngstown, Ohio, a position he had held for 15 years. Ill health during the last four years prompted his retirement from an official position with the company. He will continue, however, in a consulting capacity.

Robert W. Suman has been appointed chief engineer of Link-Belt Co.'s Philadelphia, Pa., plant. He has been chief engineer for power transmission products since 1946 and is now assuming the added responsibility of materials handling equipment engineering. **William S. Campbell,** who has been chief engineer at Philadelphia for materials handling and applied engineering products, has retired from active duty.

Andrew M. Kennedy, Jr., was named director of purchasing in charge of steel procurement for the Westinghouse Electric Corp. recently in Pittsburgh, Pa. Mr. Kennedy was formerly manager of the purchasing, stores and shipping department at the Westinghouse transformer division, Sharon, Pa.

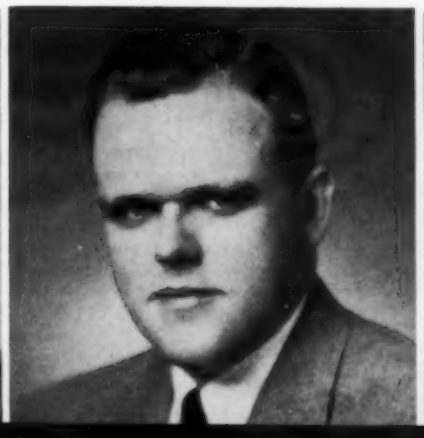
Hugo J. De La Croix and **W. D. Calhoun** have been appointed assistant supervisors of industrial relations for the Youngstown, Ohio, district of Youngstown Sheet and Tube Co. Both have been assistants to the supervisor of industrial relations.

S. F. Schulick, chief hiring clerk at the Brier Hill, Ohio, plant of Youngstown Sheet and Tube Co., has been appointed assistant supervisor of employment for the Youngstown district. He will be located at the Campbell employment office. Mr. Schulick succeeds **Frank J. Itts** who died late last year.

William F. Lucas has been appointed as assistant to the western region manager of Detrex Corp., Detroit, Mich. Mr. Lucas will make his headquarters in the Chicago, Ill., office, 600 South Michigan Avenue.

A. P. MILLER

WILLIAM H. FEATHERS



WILLIAM S. DUBOIS

E. L. CASEY

Thomas J. Hanley, Allis-Chalmers service and erection engineer at Allis-Chalmers Manufacturing Co., Milwaukee, Wisc., for the last nine years, has been promoted to supervisor of electrical and hydraulic turbine service and erection.

Addison Maupin was appointed development engineer for Chas. Taylor Sons Co., Cincinnati, Ohio, to specialize in the application of Taylor refractory products in the iron and steel industries. Mr. Maupin was graduated in ceramic engineering from North Carolina State College, Raleigh, N. C. in 1938, worked in the operating and sales departments of General Refractories Corp. until 1947, with 4 years leave of absence for service in the U. S. Army Pacific Theater. Mr. Maupin comes to Taylor following 3½ years as ceramic engineer for the Cleveland district of the Republic Steel Corp. Temporarily, Mr. Maupin will be located in the Cleveland district offices of Chas. Taylor Sons Co.

James W. Dunham, vice president of National Cylinder Gas Co., Chicago, Ill., was elected president of the International Acetylene Association at the annual business meeting held during this organization's recent Annual Convention in Montreal, Quebec. Mr. Dunham had served as vice-president for the year 1950.

A. F. Reinking, formerly assistant sales manager, has been named manager of the steam turbine sales division of Worthington Pump and Machinery Corp., Harrison, N. J. Mr. Reinking will make his headquarters at Worthington's Wellsville plant.

Thomas R. Lawson has been appointed assistant sales manager of industrial products for the Westinghouse Electric Corp. Mr. Lawson will be located in headquarters offices in Pittsburgh. His duties will include responsibility for coordination of industrial products, defense planning and new product planning from the commercial standpoint. He will work with division sales and application data and training departments on negotiation procedures and other matters.

Robert E. Ferry has recently been appointed manager of apparatus sales offices in Wheeling and Fairmont, W. Va., for Westinghouse Electric Corp. Mr. Ferry will be located in the National Bank of West Virginia building, in Wheeling.

Fred H. Haggerson, president of Union Carbide and Carbon Corp., has also been elected chairman of the board of directors. Mr. Haggerson has been president of Union Carbide since 1944, and has been associated with the corporation for over 30 years.

Nelson Evans Cook, general superintendent of galvanizing for the Wheeling Steel Corp. was the recipient of the Annual Award of the Galvanizers Committee, which is holding its 25th meeting coincidentally with the annual convention of the zinc industry.

John H. Mackey has been appointed assistant superintendent of Youngstown Sheet and Tube Co.'s Brier Hill, Ohio, blast furnaces. He succeeds **Roy H. Nelson** who recently was appointed assistant superintendent of Hubbard blast furnace.

Heroult

ELECTRIC MELTING FURNACE

. . . as ever, the dependable furnace for the production of high-grade stainless, alloy and rimming steels.

Removable roof of new design now available for the larger furnaces.

AMERICAN BRIDGE COMPANY

General Offices: Frick Building, Pittsburgh, Pa.

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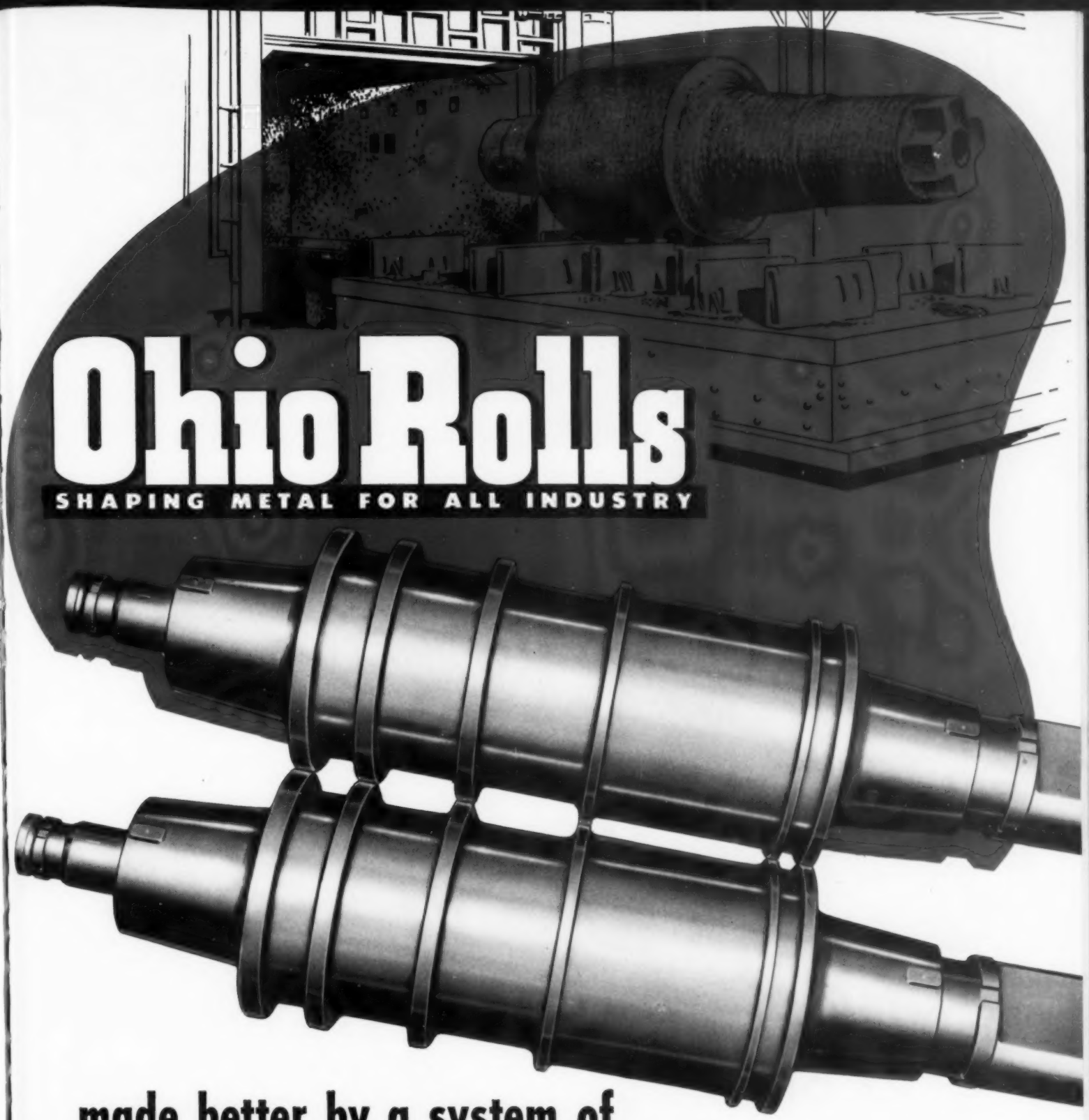
United States Steel Export Company, New York

USS

AMERICAN BRIDGE

UNITED STATES STEEL



Ohio Rolls

SHAPING METAL FOR ALL INDUSTRY

made better by a system of INTEGRATED PROCESS CONTROL

Select from any of these eleven types of Ohio Steel and Iron Rolls:

Carbon Steel Rolls	Denso Iron Rolls
Ohioloy Rolls	Nickel Grain Rolls
Ohioloy "K" Rolls	Special Iron Rolls
Holl-O-Cast Rolls	Nioloy Rolls
Chilled Iron Rolls	Flintuff Rolls

Alloy Chilled Iron Rolls

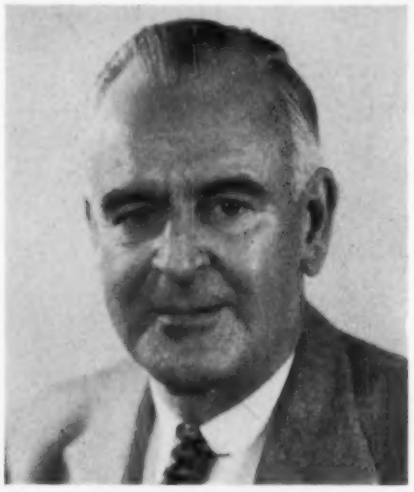
Unique in roll manufacturing is Ohio Steel's Integrated Process Control. The same team of specialists is responsible for quality from receipt to shipment of your order. This group of metallurgists, chemists, engineers and inspectors establishes standard practice procedures and testing requirements for every department. So highest quality is maintained.

THE OHIO STEEL FOUNDRY CO. LIMA, OHIO

PLANTS AT LIMA AND SPRINGFIELD, OHIO

John Seagren has been appointed chief engineer of National Supply Co.'s engine division at Springfield, Ohio.

T. D. Harter has been appointed eastern district sales manager of the clamshell bucket department of Blaw-Knox division of Blaw-Knox Co. Mr. Harter will



T. D. HARTER

work out of both the New York and Philadelphia district offices of the company and his main headquarters will be in the latter office.

Dr. Louis T. Rader has been appointed assistant manager of engineering of the General Electric Co.'s control divisions at Schenectady, N. Y.

Rudolf Becker, chief engineer of Gesellschaft fuer Linde's Eismaschinen, is now associated with Chemical Plants division of Blaw-Knox Co., in connection with the design and construction of plants for making tonnage oxygen, nitrogen, hydrogen, and other products of low temperature processing.

Claude J. Peck, has been elected vice president of Shenango Furnace Co., Pittsburgh, Pa. For the past 30 years, vice president Peck has been manager of the company's Cleveland office, located in the Union Commerce Building, and in that capacity has been in charge of Shenango Furnace Co.'s fleet of lake ore carriers. Mr. Peck will remain in Cleveland and will continue to head the company's lake shipping interests.

T. I. Phillips, vice president of the Westinghouse Electric Corp. and formerly in charge of the company's East Pittsburgh divisions, has been assigned to the staff of industrial products vice president to help plan and carry out the company's extensive industrial products expansion program.

Patrick Dolan has been named district manager of the newly established Baltimore, Md., office of Patterson Foundry & Machine Co., East Liverpool, Ohio. Mr. Dolan has been a sales engineer at the main offices for a number of years. The Baltimore office will be located at 1605 Court Square Building.

Dr. George O. Curme, Jr. has been elected vice president in charge of research of Union Carbide and Carbon Corp., New York, N. Y.

Jones

Herringbone SPEED REDUCERS—

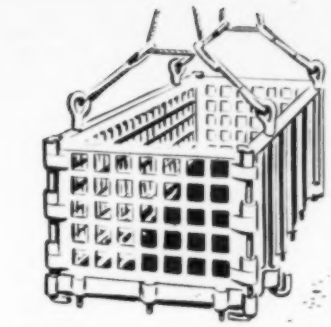
. . . are built in single, double and triple reduction types. Symmetrical gear arrangement provides balanced loads on liberally proportioned bearings. Housings are substantially constructed, well ribbed and have generous pads for foot bolts.

The method of selecting these reducers with complete horsepower and dimension tables is shown in Catalog 70.

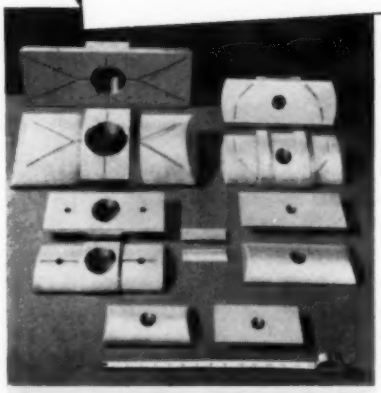
Since 1890 Jones In The Service Of Industry

W. A. JONES FOUNDRY & MACHINE CO.
4431 W. Roosevelt Rd., Chicago 24, Ill.

Herringbone — Worm — Spur — Gear Speed Reducers
Cast Iron Pulleys • Cut Gears • V-Belt Sheaves
Anti-Friction Pillow Blocks • Flexible Couplings



Pickling Costs Dip...



CAST-TO-SIZE SLIPPERS

Protect your production schedules with wear-resistant Ampco Metal "cast-to-size" slippers. Furnished to $+\frac{1}{32}$" -0", or $-\frac{1}{32}$" $+0$" tolerances with oil-grooves cast-in to requirements. Accurate surface finishes eliminate necessity of machining.

when you use corrosion resistant

AMPCO* METAL

- **to reduce replacement costs**
- **to cut down-time losses**

Ampco Metal crates, baskets, yokes, chains and other pickling equipment meet the "acid-test" with their outstanding resistance to corrosion from sulphuric acid pickling solutions.

Put them to work for you and watch your costs dip and your profits rise. They stay on the job longer, save hours of downtime and hold maintenance, repairs, and replacement to a minimum.

See your nearby Ampco field engineer for complete details about the Ampco alloy that meets your needs best — for pickling equipment and many other steel mill applications where tough, wear-resistant Ampco Metal can save you money.

*Reg. U. S. Pat. Off., Ampco Metal, Inc., Milwaukee, Wis.

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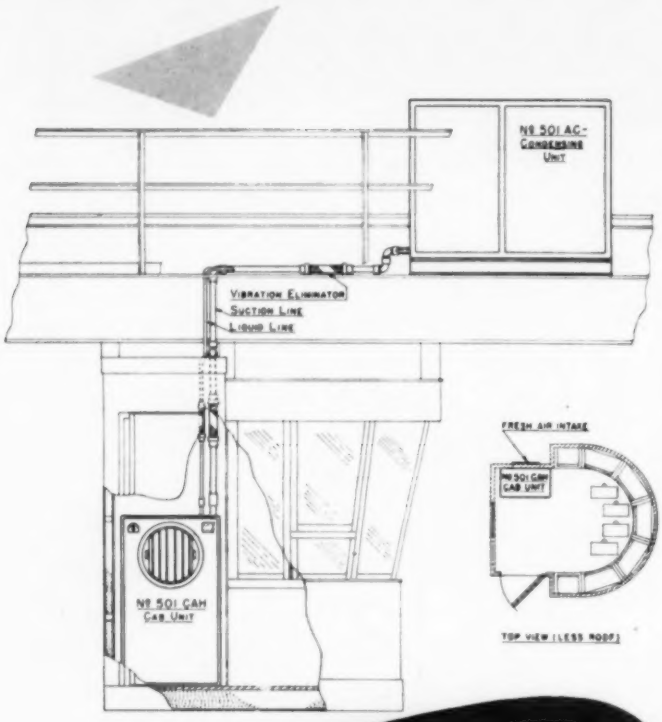
Ampco Metal, Inc.

1710 SOUTH 38TH STREET • MILWAUKEE 46, WIS.

West Coast Plant: Burbank, California



How to Save 2/3 on Your Crane Cab Air Conditioning

By arranging for air conditioning with the Lintern Aire-Rectifier *when buying the crane*, the cost is only about one-third that of installing air conditioning later.

A majority of the steel companies, in their expansion programs, have included air conditioned crane cabs.

Aire-Rectifiers hold cabs at a cool 85° F and relative humidity of 30% to 50% at ambient temperatures of 170° without excessive head pressures or wear on the machine.

In the split system (shown above) the condenser is located at any convenient place on crane, and evaporator (cooling coil) is placed in cab. The two units are connected with refrigerant lines properly secured and protected against breakage. Condensers are air-cooled, assuring trouble-free service with but little maintenance.

May we send you complete information on the Lintern Aire-Rectifier (patents pending) and its application to your particular needs?

THE LINTERN CORPORATION

29-2 RIVERSIDE DRIVE • BEREA, OHIO

W. A. Yost has been placed in charge of a newly organized mechanical power department at Allis-Chalmers Manufacturing Co., Milwaukee, Wisc. Mr. Yost had been manager of Allis-Chalmers steam turbine department since 1947.

Walter K. Palmer, accounting manager for Kaiser Steel Corp., Oakland, Calif., has been appointed an assistant controller and director of cost control.

Robert L. Craig, supervisor of employment for Youngstown Sheet and Tube Co., Youngstown, Ohio,

ROBERT L. CRAIG

since August 1, 1949, has been appointed assistant to the director of industrial relations. **George B. Curl,**

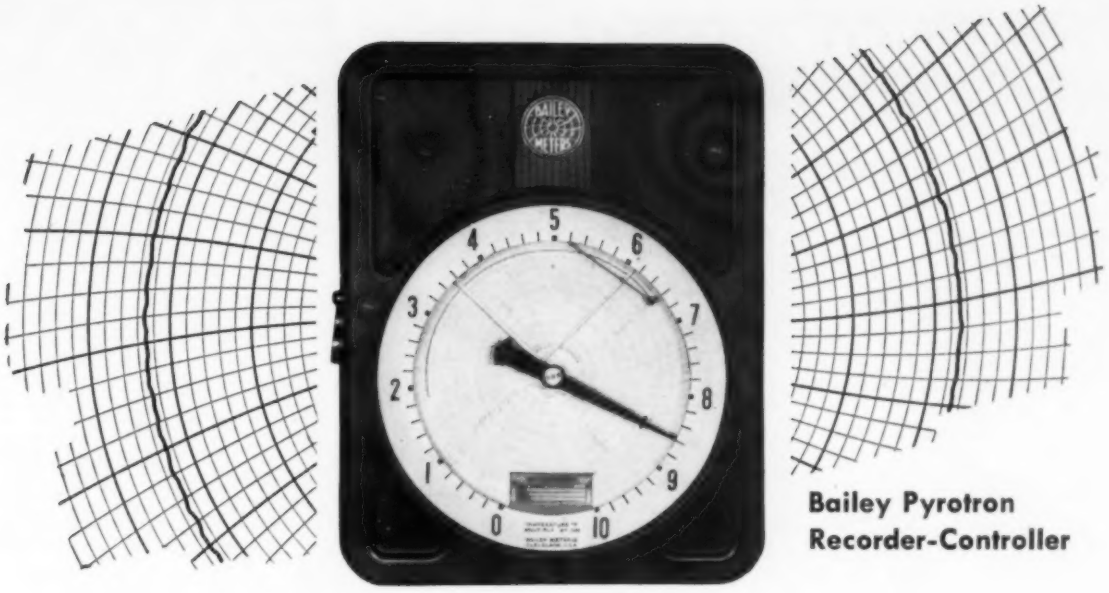
GEORGE B. CURL

assistant to the supervisor of industrial relations in the Youngstown district, succeeds Mr. Craig as supervisor of employment.

Dr. Max Hansen, 50, German metallurgist, has been named assistant chairman of the metals department of Armour Research Foundation of Illinois Institute of Technology.

Donald N. Watkins, who has been president and treasurer of Laclede-Christy Co., Pittsburgh, Pa. was elected chairman of the board and president.

Frank Senzik has been appointed assistant superintendent of construction for the Youngstown, Ohio, district of Youngstown Sheet and Tube Co.



Bailey Pyrotron Recorder-Controller

Looking for Better Temperature Instruments?

...Then check these features of Pyrotron Electronic Resistance Thermometers...

FUNDAMENTAL ACCURACY

Bailey Pyrotron Resistance Elements are made of highest purity platinum—the material used by the National Bureau of Standards in establishing basic standards for temperatures from −190°C to +660°C.

THREE TYPES OF CONTROL

Pyrotron Controllers may operate: on-off electrical systems by either electronic relays or electric contacts, modulated electronic systems, or air-operated systems. Two temperatures may be recorded on the same chart and controlled by a single instrument.

FACTS PUT INTO USABLE FORM

Bailey Pyrotrons may be arranged to put temperature facts into convenient usable forms. If two or more temperatures are related, they may be recorded as continuous records on the same chart for easy comparison. The average of several temperatures or the difference between two temperatures may be recorded as a single continuous record which may be retransmitted to a distant point or used to actuate a control system.

EASY INSTALLATION

Bailey Pyrotrons do not require careful leveling or protection against vibration. Three ordinary copper wires are all that is needed to connect each temperature sensitive element with the recorder. Power may be taken from any 115 volt 60 cycle circuit.

MINIMUM MAINTENANCE

The absence of galvanometers, batteries and standardizing equipment, together with the use of interchangeable unit assemblies, reduces Pyrotron maintenance to the vanishing point.

ABUNDANT POWER

A separate motor drive for each temperature furnishes abundant power to operate a recording pen, a controller and an alarm switch.

For the full story on this unusual electronic resistance thermometer which is suitable for ranges between −300°F and 1200°F, ask for Bulletin No. 230-C. P-21

BAILEY METER COMPANY

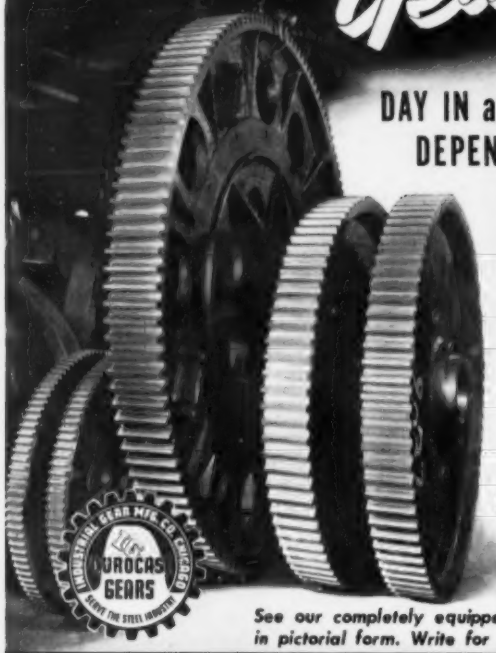
1047 IVANHOE ROAD • • • CLEVELAND 10, OHIO

Controls for Processing

TEMPERATURE
PRESSURE
% OXYGEN
% COMBUSTION
FLOW
LEVEL
DENSITY
RATIO

Only One Quality....THE BEST!

"Industrial Gears"



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on all your essential drives... is yours when you specify "IG" DUROCASE GEARS

Let us help you with your problems

See our completely equipped plant in pictorial form. Write for booklet.

INDUSTRIAL GEAR MFG. CO.

4527 VAN BUREN STREET CHICAGO 24, ILLINOIS

Paul S. Kempf has been appointed manager of industrial relations of Inland Steel Products Co. Mr. Kempf will transfer to the Milwaukee, Wisc., headquarters of the company which is a manufacturing subsidiary of Inland Steel Co.

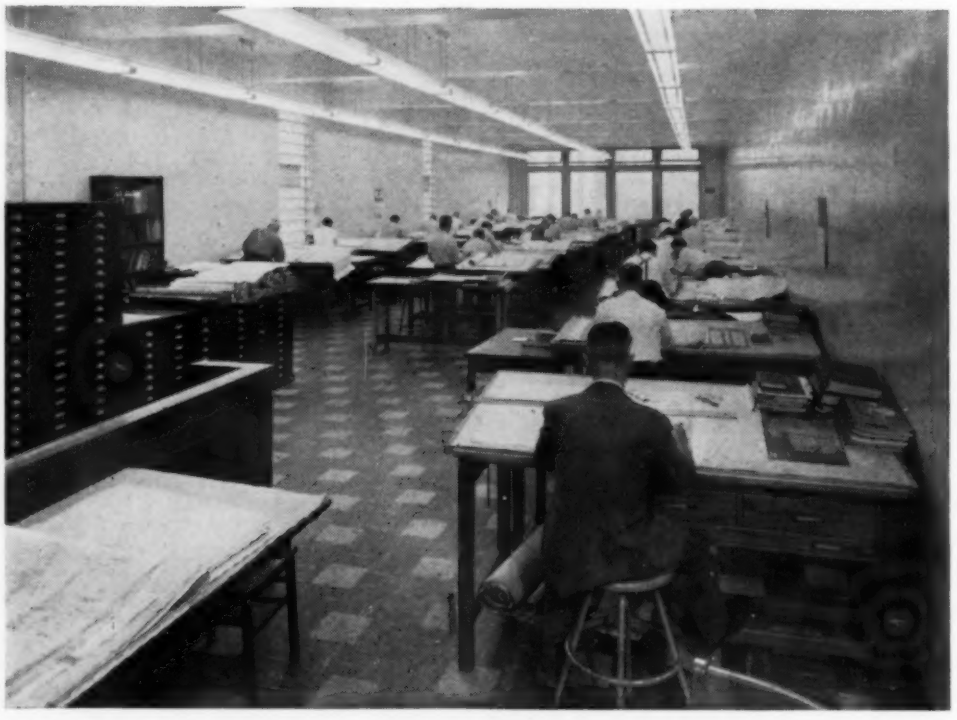
Donald I. Bohn, chief electrical engineer, Aluminum Co. of America, will be awarded the 1950 Lamme gold medal awarded annually for meritorious achievement in the development of electrical apparatus or machinery, on June 25 during opening sessions of the five-day summer general meeting of the American Institute of Electrical Engineers at Toronto, Canada.

Wilbert G. Nichol and **Walter N. Flanagan,** of United States Steel Co., Pittsburgh, Pa., were awarded the American Iron and Steel Institute Medal for 1950 at the 59th general meeting of the Institute in the Waldorf-Astoria Hotel, New York. A newly established award, the Regional Meeting Technical Award, also for 1950 was presented to **H. E. Warren, Jr.,** of United States Steel Co. Mr. Nichol is assistant chief industrial engineer for his company and Mr. Flanagan is fuel and furnace engineer. Mr. Warren is assistant general superintendent of the new Fairless works of United States Steel Co.

Joseph G. Surmacz has been named to the newly created position of chief industrial engineer of Harnischfeger Corp., Milwaukee, Wisc. **David A. Drewery** was named to assist Mr. Surmacz as plant industrial engineer.

A COMPLETE *Steel Mill* Engineering Service

The photograph at the right is a partial view of the new and enlarged York offices and drafting room at 951 Penn Avenue, Pittsburgh, where we have facilities for a complete engineering and construction service for steel mills. This includes the design of buildings, foundations, and equipment, as well as project planning, coordination, and cost control. Write for information about our services.



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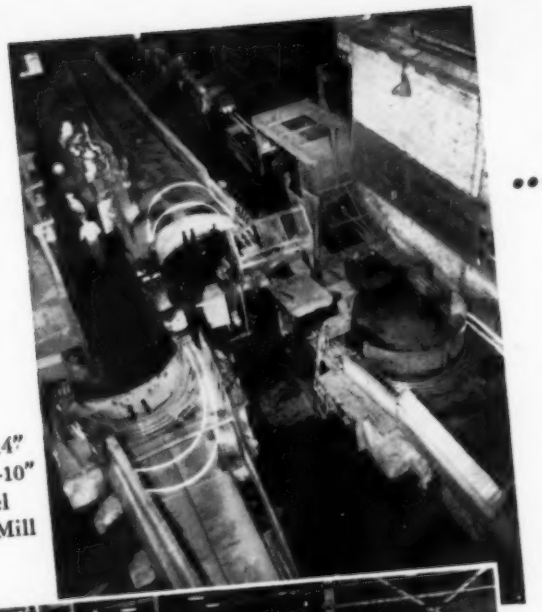
ENGINEERING & CONSTRUCTION CO.

951 PENN AVENUE PITTSBURGH 22, PA.



View of 14" —12"—10" Mild Steel Rod Mill

...When it's tonnage that counts

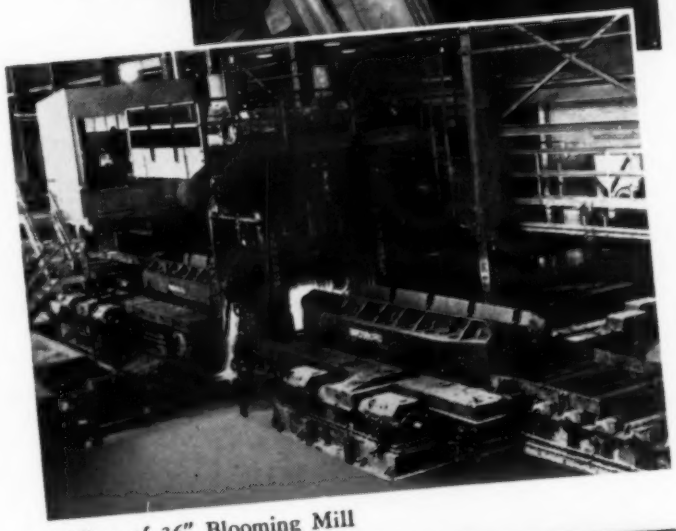
depend on

BIRDSBORO

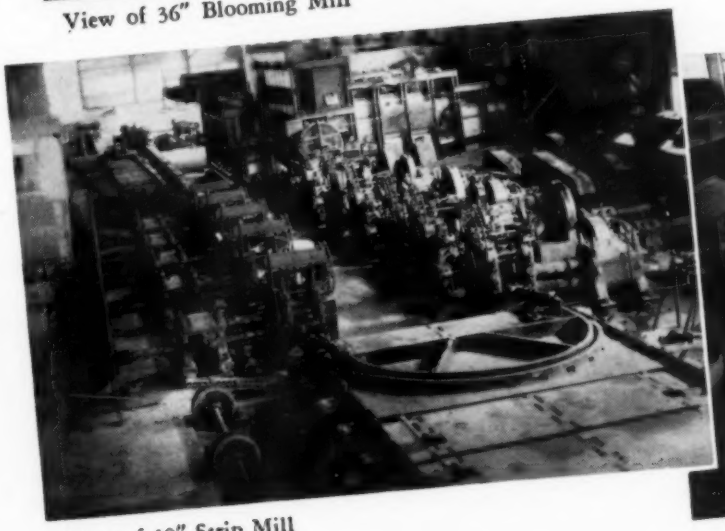
STEEL MILL MACHINERY

For producing Blooms, Billets, Rod, Strip and Merchant Bar.

Birdsboro engineering skill makes possible modern equipment like this that you'll find in leading mills mass-producing billets, rod, sheet, strip, plate and other products to meet today's critical demands. Whenever you find it necessary to modernize your present equipment or add to your facilities—it may be this year or the next—Birdsboro engineers will be glad to work with you on your individual problems.



View of 36" Blooming Mill



View of 10" Strip Mill

View of Merchant Mill

BIRDSBORO

STEEL FOUNDRY & MACHINE CO.

Birdsboro, Penna.

Offices in: Birdsboro, Pa. and Pittsburgh, Pa.

STEEL MILL MACHINERY

Designers and Builders of:

Steel Mill Machinery • Crushing Machinery • Rolls

Hydraulic Presses • Special Machinery • Steel Castings

MM-16

CRANE BUILDERS Since 1903

BEDFORD CRANES

Capacities 5 to 150 Tons

Any Span or Lift
Send For Your
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Designed and
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ELECTRIC OVERHEAD TRAVELING CRANES
GANTRY CRANES • STEEL DERRICKS
BUILT TO YOUR SPECIFICATIONS
STRUCTURAL STEEL • STEEL BUILDINGS

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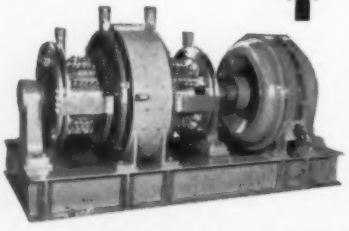

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Electroplating
Anodizing
Electrocleaning
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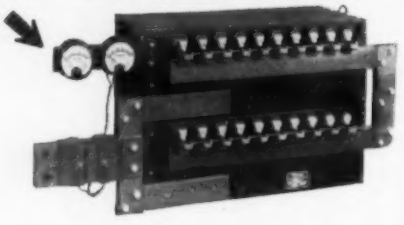
TANK RHEOSTATS



• TONG TEST AMMETERS

• REVERSING SWITCHES

Write for Descriptive Bulletins

COLUMBIA ELECTRIC MFG. CO.
4543 HAMILTON AVE. CLEVELAND 14, OHIO

Morse G. Dial has been elected executive vice president of Union Carbide and Carbon Corp., New York, N. Y. In 1937 Mr. Dial became assistant secretary and treasurer of Union Carbide, and in 1945 he was elected secretary and treasurer. Since 1949 he has been director, vice president, and treasurer.

Jack J. Tipton was appointed chief project engineer for Hays Corp., Michigan City, Ind. Until his present

JACK J. TIPTON

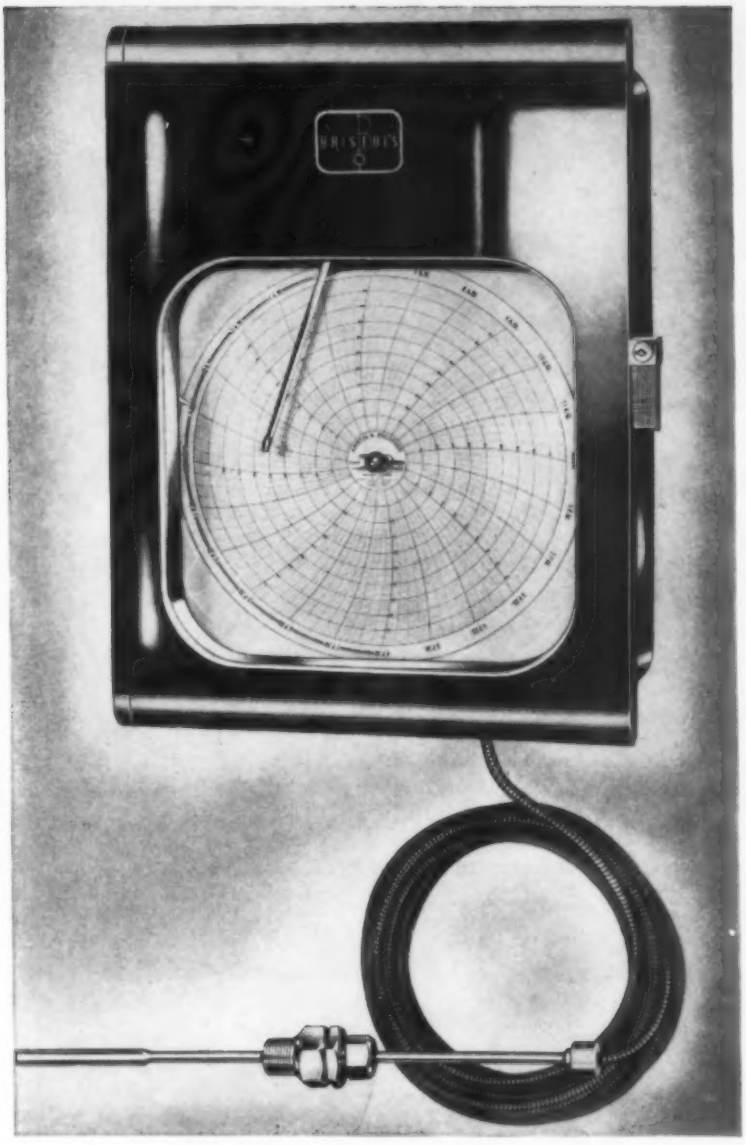
appointment Mr. Tipton was project engineer primarily concerned with combustion control. **John R. Heming** was named project engineer in charge of combustion control.

JOHN R. HEMING

Glenn R. Smith has been appointed district sales manager for Electric Service Manufacturing Co., in its Washington, D. C. office. Mr. Smith was previously in the Detroit, Mich., office. He has been replaced there by **Walter W. Dearolf, Jr.,** who moves from Philadelphia, Pa.

Benjamin F. Fairless, president of the United States Steel Corp. was awarded the Bessemer Medal for 1951 by the British Iron and Steel Institute, in recognition of his distinguished services to the iron and steel industry. The presentation was made in behalf of the Institute by Sir Charles Goodeve, director of the British Iron and Steel Research Association, at the 59th general meeting of the American Iron and Steel Institute at the Waldorf-Astoria Hotel.

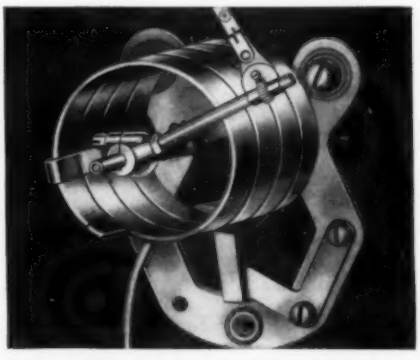
NEW SERIES 500 RECORDING THERMOMETER CARRIES ON THE BRISTOL TRADITION



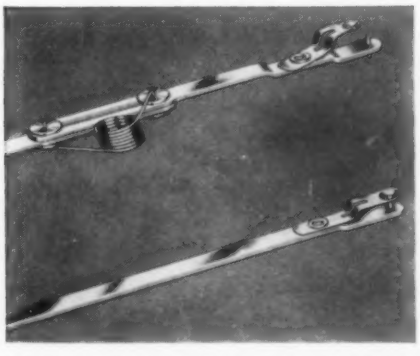
The Bristol Series 500 Recording Thermometer for temperatures between minus 125 F and 1000 F incorporates every modern improvement for dependable accuracy, ease of use and convenient servicing.

In addition, it represents all the wealth of thermometer "know-how" gained by nearly 60 years of experience in building hundreds of thousands of recording thermometers—known all over the world for their high accuracy and dependability.

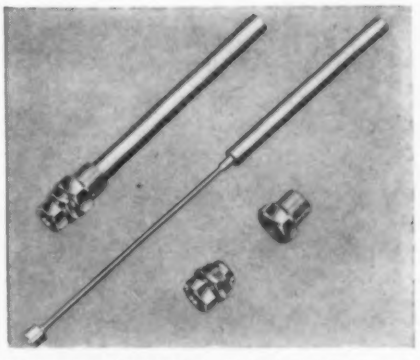
Send for the new Thermometer Catalog T840. Address THE BRISTOL COMPANY, 123 Bristol Road, Waterbury 20, Conn.



MORE SECURELY SEALED—TROUBLE-FREE—The measuring system is securely sealed against leakage. Parts are joined with silver solder by induction heating.



STURDY, FRICTION-FREE CONNECTION between measuring element and pen arm mechanism is provided by strong, adjustable links with polished stainless steel pins.



FLEXIBLE ARMOR is interlock-type, withstands heaviest abuse. *Bulbs*—plain, union or socket type—easily converted.

BRISTOL

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

Mill Type Cranes BUILT BY *Browning*

HAVE *Strength* WHEREVER STRENGTH IS NEEDED

Satisfying A.I.S.E. specifications, Browning Mill Type Cranes incorporate types of motors and controls on which you have standardized. This flexibility suits your VRB crane *perfectly* to your needs. Our design, springing from 49 years' experience, places plenty of strength where it is required.

Ask for our Bulletin "E"

Husky 10-ton mill type trolley equipped with separate load girt for easy removal.

VICTOR R. BROWNING & COMPANY, Inc.
BOX 309, WILLOUGHBY (CLEVELAND), OHIO
Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

MARK LADLE-TEST PIECES

THE SAFE EASY WAY

with the "SAFETY" BOX TYPE HOLDER

Mark ladle-test pieces with furnace number, year-code letter and heat numbers—in 50% less time with this type holder. Complete mark is made with one blow. Marks are in straight line, of even depth, easy to read—reduces errors in stamping and identifying tests. Eliminates danger of hitting fingers with hammer. *Write for proposal on your needs.*

M.E. CUNNINGHAM CO.
SAFETY STEEL STAMPS
105 East Carson Street • Pittsburgh 19, Pa.

Obituaries

B. T. Dye, industrial relations superintendent at Republic Steel Corp.'s Buffalo, N. Y. works, died, May 20. With Inland Steel from 1923 to 1933, Mr. Dye joined Republic in July 1933, as safety supervisor at the firm's Warren, Ohio, works. He transferred to Republic's Buffalo works as assistant superintendent, industrial relations in July 1940, and in September 1942, he was named superintendent.

T. M. Heerman, 62, assistant manager of sales of Allis-Chalmers centrifugal pump department, died suddenly May 17, in Milwaukee, Wisc.

Alexander Smith, 58, assistant chief engineer, Farrel-Birmingham Co., Ansonia, Conn., died recently.

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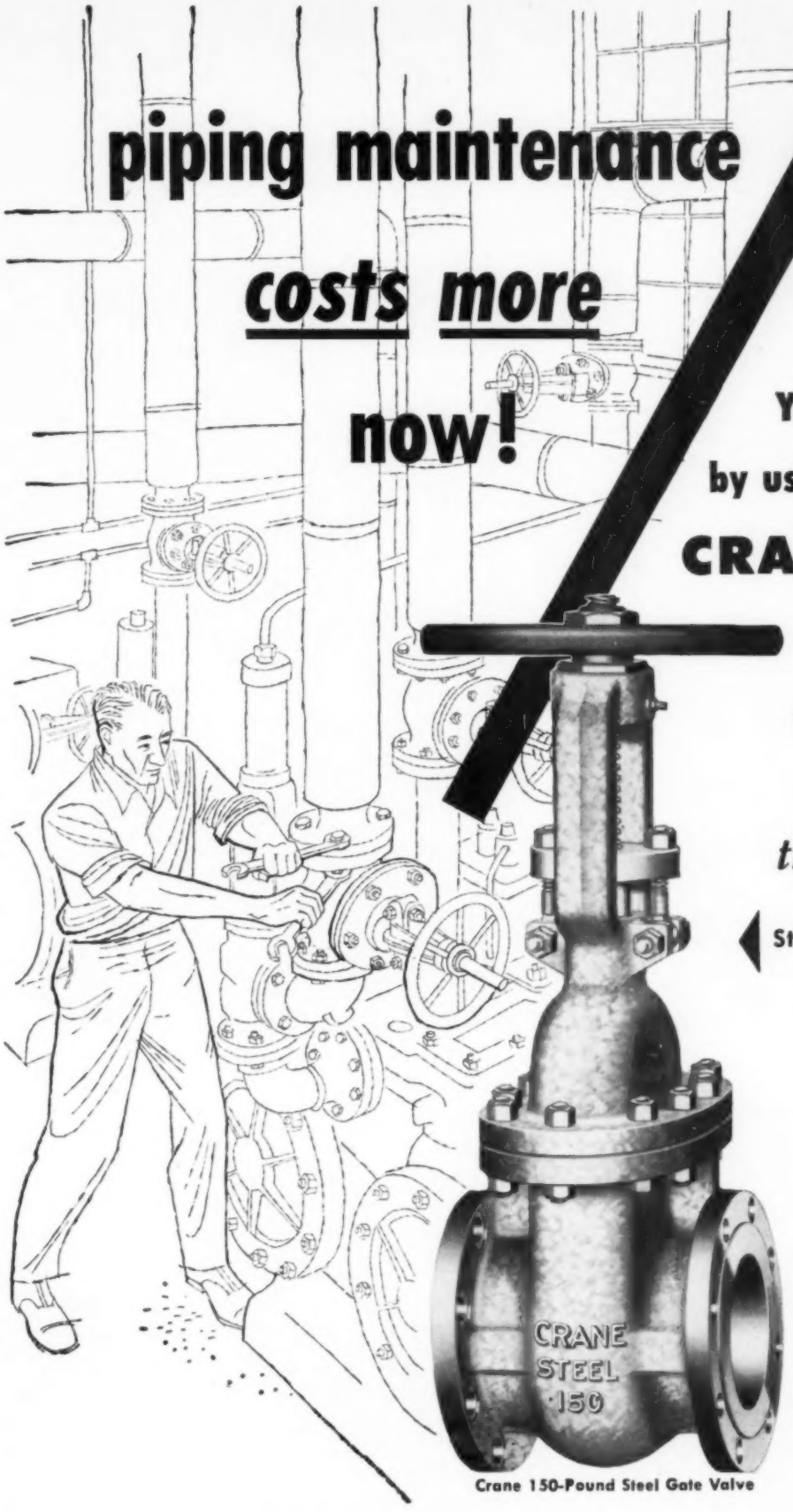

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. . . That's why more Crane Valves are used than any other make

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You can practically forget valve maintenance worries with Crane Cast Steel Wedge Gates. They're unusually rugged . . . amply reinforced at all stress points. Disc is precision-guided to reduce seating surface wear. Straight-through ports give smooth flow, with minimum turbulence and erosion.

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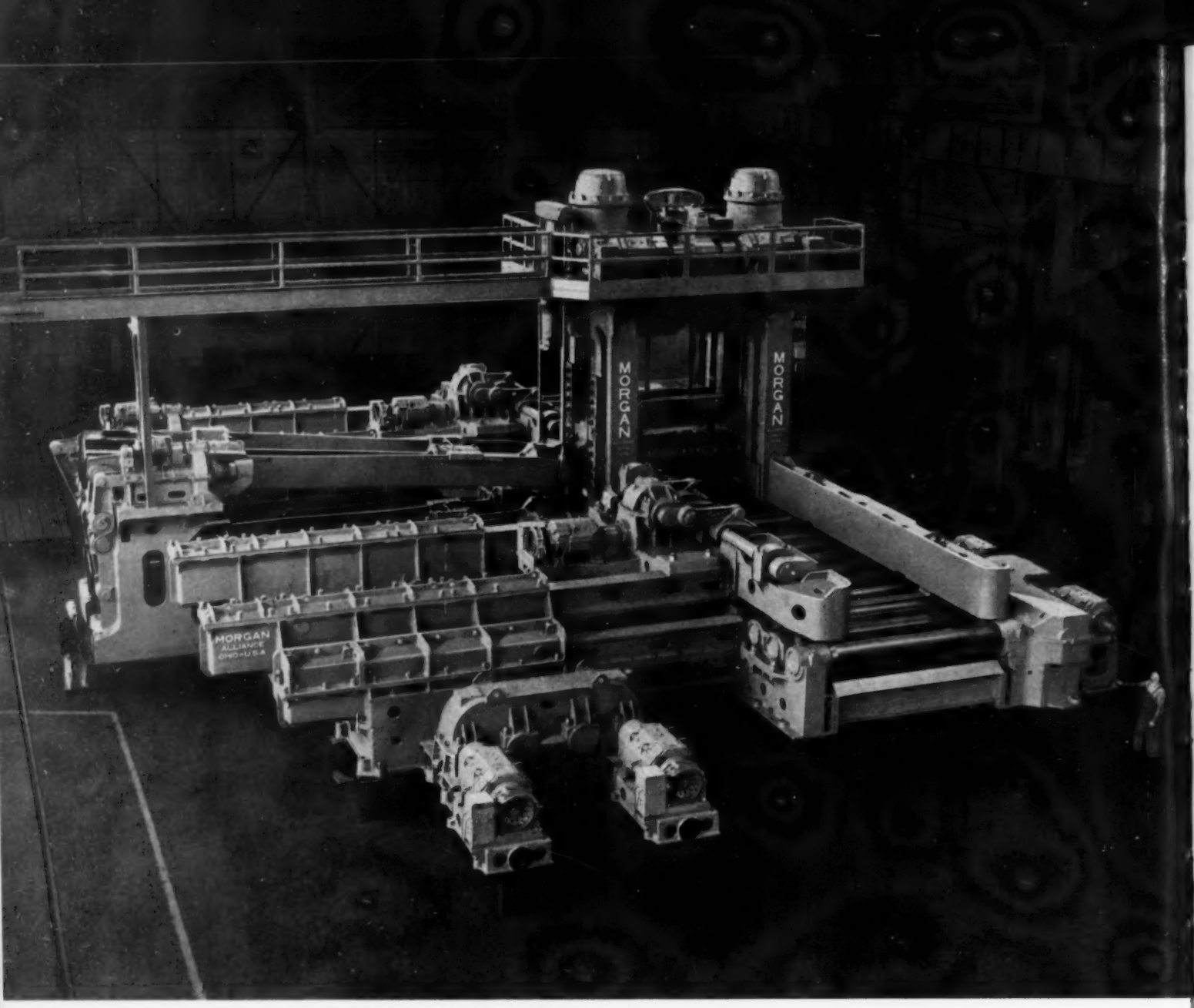

44" TWIN MOTOR DRIVE BLOOMING MILL

Morgan 44"—2 High Reversing Blooming Mill to be direct connected to two 4000-Hp., 50/120 Rpm. Motors. Top roll and both spindles are hydraulically balanced by individual cylinders connected to an air hydraulic system. Speeds of motor driven screw down, feed rollers, mill tables and manipulator are regulated by variable voltage control.

Mill tables have box type cast steel girders. Rollers are forged steel equipped with anti-friction type bearing cartridges. All gears have hardened teeth, are totally enclosed and operate in oil. Manipulator is of the electric overhead type with retractable heads affording maximum accessibility to all parts of the mill tables.

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Equipment News...

J & L BLOOMING MILL

▲ Approximately $2,500,000 worth of electrical equipment will be supplied by Westinghouse Electric Corp. for the newest blooming mill in the Pittsburgh district — a 46-in. high-lift mill to be installed at the Jones & Laughlin Steel Corp.'s South Side works. New design features and a special control scheme will provide rapid reversals, making this mill one of the fastest of its size ever to be built.

The main reversing drive will total 10,000 hp, delivered by twin 5000-hp, d-c reversing motors coupled directly to the upper and lower rolls. The speed range of these motors will be from 40 to 100 rpm.

A flywheel motor-generator set having four 2500-kw generators will supply d-c adjustable-voltage power to the main drive motors. The flywheel on this set will have 250,000 hp-seconds stored energy when running at 514 rpm. An 8000-hp wound-rotor motor will drive the d-c generators, and will be controlled by a new type liquid slip regulator. This regulator will permit the flywheel to give up its energy when peak loads are applied to the twin main drive motors during reversals.

Westinghouse-developed Rototrol rotating regulators will provide load balance between the twin motors of the main drive, and between the four 2500-kw generators.

Mill auxiliaries will be driven by both constant-voltage and adjustable-voltage d-c motors and by a-c motors, all of which will total approximately 6000 hp. Rototrol regulators and special control schemes will be used where necessary to provide the fast operation necessary to match the speed of the main drive.

A Westinghouse semi-automatic Precipitron electronic air cleaner and Westinghouse Sturtevant fans will keep the motor room pressurized with clean air. This equipment also will supply clean ventilating air to motors located outside the main motor room.

Power for the mill will be supplied at 13,800 volts, 3 phase, 60 cycles, and distributed through Westinghouse switchgear, transformers, and power centers.

The mill is expected to be in operation in the first half of 1952.

CRANE CAB COOLING

▲ New type equipment for air conditioning the cabs of cranes operating in high temperatures or in atmospheres contaminated by toxic and noxious gases or dusts, has been developed by Dravo Corp.

With the new equipment, known as the "Split-Type Crane Cab Cooler," no ductwork is needed for installation because the cooling section is installed in the cab itself and the larger condenser section is placed outside on the crane in any convenient location.

Like other models of Dravo crane cab coolers, the new split-type unit provides constant, year-round ventilation, filters the air to remove dust, dirt and fumes, cools the air in the summer and, if necessary, heats the air during the winter.

The cooling section, which goes into the cab, is housed in an attractive aluminum finish cabinet. There is ample room for the unit in most crane cabs. The only connections between it and the condenser unit outside the cab are power lines and refrigerant piping.

Thermostatically controlled, the split-type crane cab cooler will maintain a temperature of 80 to 85 F when the outside ambient temperature is 175 F. During the heating cycle, the unit keeps the temperature in the cab at 68 to 75 F with an ambient temperature of zero outside.

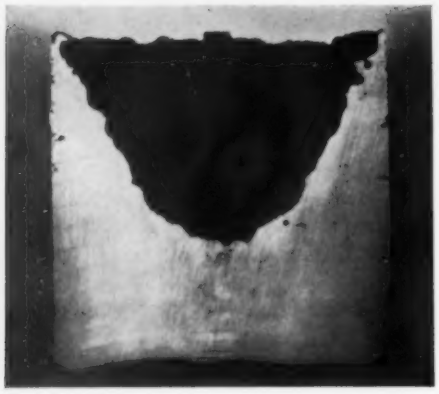
Company engineers said the split-type unit can be installed easily and quickly on any type of crane, or in control pulpits, with a minimum of down-time. Typical installations include cranes working over or around soaking pits, open hearth furnaces, bessemer converters, stripping operations and blast furnaces.

HOT TOPPING COMPOUND

▲ With world conditions making demands for every possible pound of steel, the Lukens Steel Co., one of America's pioneer steel makers, is making important savings every heat through the use of a newly developed hot-topping compound. This compound, called "Mexatop," was developed by U. S. Graphite Co., in conjunction with the open hearth and research departments of Lukens. Subjected to rigid tests before used on

LINK-BELT BUILDING NEW EASTERN PLANT

Link-Belt Co. has started construction of a modern engineering and manufacturing plant for the production of elevating, conveying and processing machinery, on a 43-acre site at Colmar, Montgomery County, Pa., on the Doylestown branch of the Reading Railway. Colmar is 3½ miles from Lansdale.



production, "Mexatop" has enabled Lukens to cut the poured height of hot-tops by 2 in. and reduce the metal in the hot-top by 1.5 per cent on maximum weight ingots according to company engineers. Records show a saving of 3,000 to 4,000 lb per heat. Lukens engineers have also found that the use of the compound gives a desirable U-shaped cavity in the hot-top rather than the objectionable V-shape.

IS HEAT SLOWING UP YOUR WORKMEN?

TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep them COOL

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TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY

245 MAIN ST., HARMONY, PA.

HIGH-SPEED RECORDER

▲ A new electronic, high speed pen recorder for measuring rapidly changing variables experienced in laboratory and test applications has been developed by Minneapolis-Honeywell Regulator Co.

Full-scale signals which vary as rapidly as 20 cycles a minute can be recorded on the new model, also those with peak-to-peak amplitude of 10 per cent of scale which vary as rapidly as three cycles a second.

The new device, it was announced by the company's Brown Instruments division, will provide accurate recording in rocket engine testing where thrust of the engine is measured with a strain gauge. It will be applicable for analyzing fuel efficiencies and engine designs, and for spectrographic and other analyses where relatively high scanning rates and narrow increments of change are encountered in a measured variable. It is also used for determining instantaneous rates of flow as in jet engine development.

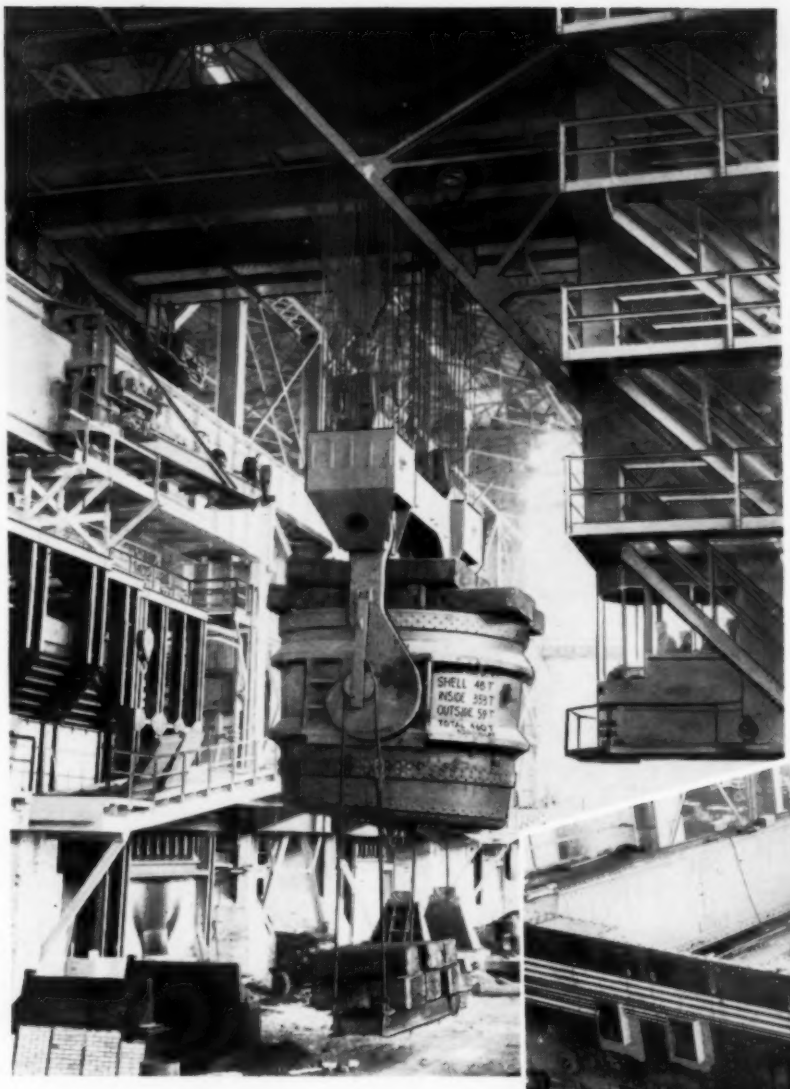
The new instrument is available at this time, with deliveries in about three months.

WATERPROOF TERMINALS

▲ Many cable users have been looking for a simple and reliable method for making waterproof terminals at the sheath termination of multi-conductor "Okoprene" sheathed control and signal cables. Waterproof terminals are desired in order to prevent the entrance and collection of water around the conductors under the sheath. Water may be present at the cable termination, due to condensation within the enclosure or leakage into the enclosure in which the cable is terminated.

In the past these cables have been terminated by cutting back the sheath

An end seal has been developed for making waterproof terminations on multi-conductor cables.



New 300-Ton Ladle Crane with EC&M CONTROL

Successfully handles test load of 460 tons

(At right) View of 300-Ton Ladle Crane during assembly on erection floor of Morgan Engineering Co., Alliance, Ohio

Safe raising and lowering of not only a test load but full ladles of molten metal is a prime requisite of ladle crane control. EC&M's Wright Circuit for crane-hoists is simplified, safe—and provides the operator with direct control (from the Master switch) of all loads in the lowering direction.

Note the width of this ladle crane. Six motors (3 on a side) are operated as 3 pairs of 2 motors in parallel to drive the bridge motion. EC&M Duplex Controllers help insure that the pairs of motors divide the load between each other. Current peaks during starting, accelerating, plugging and re-acceleration are accurately matched in each motor circuit by this EC&M Control Method.

When buying cranes, specify EC&M Control.

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79TH STREET • CLEVELAND 4, OHIO

and fillers for the required length, and in some cases wrapping with friction tape or serving with string. Such methods have the disadvantage that they are not waterproof, and there is some possibility that the individual insulated conductors may be damaged at the sheath termination, if they are placed under tension when fanned out. Attempts have been made to form a seal by pouring hot compound into sheet metal, cardboard or other forms, but these have not been satisfactory because the form does not make a tight seal with the cable, resulting in compound leaks and a poor-appearing finished job when the form is removed.

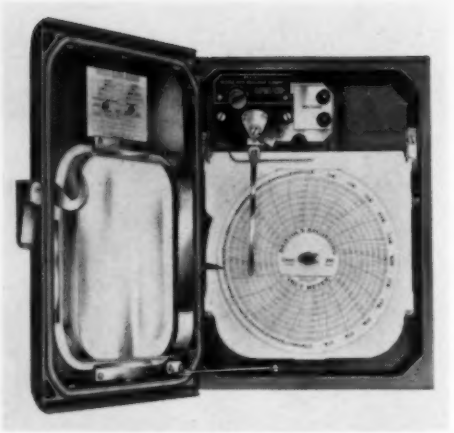
The "Okoprene" end seal has been developed for making waterproof terminations on multi-conductor cables and to provide good mechanical protection for the conductors at the sheath termination. This method is applicable to cables having a diameter over the sheath of 0.75 in. to 2 in.

The end seal provides a permanent mold for holding the sealing compound. The tapered end of the cone is designed to provide a perfect fit for any specified diameter. When snugly fitted over the cable sheath, it prevents compound leakage and keeps the termination clean and neat-appearing.

ELECTRIC RECORDERS

▲ A new line of recording voltmeters and ammeters, identified as the "Series 500" electric recorders, has just been announced by Bristol Co. These instruments make a continuous record of voltage or current on an 8-in. circular chart, similar to previous models made by the company for many years. However, the new instruments feature an entirely new measuring mechanism and a number of other basic improvements. The new moving-iron measuring mechanism produces a high actuating torque at a low electrical burden. The mechanism has shock-protected precision stainless steel bearings, magnetic damping, and a locking device to prevent damage due to rough handling.

The instruments are housed in a compact die-cast aluminum alloy case which is moisture-, fume-, and dust-proof. Recording ammeters and voltmeters are both furnished in a variety of models for wall, surface-panel or flush-panel mounting, for either open terminal or conduit connection, as well as portable and pole mounting models.



These instruments make a continuous record of voltage or current.

GAS INDUSTRIAL TRUCKS

▲ The largest single order of gas industrial trucks in the 82-year history of Yale and Towne Manu-

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DO YOU KNOW THEIR 9 BIG ADVANTAGES?
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This new FREE booklet tells how two new types of Oakite-developed solvent detergents make it easier and cheaper for you to do many difficult metal-cleaning jobs. Here are some of the subjects covered in the booklet:

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How to use Oakite solvent detergents:
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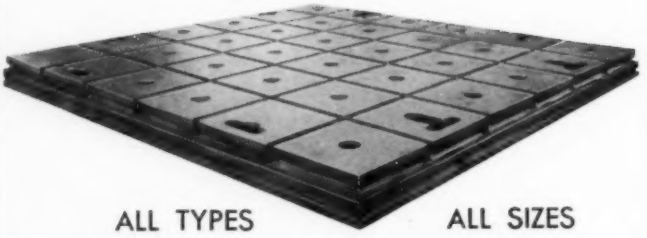

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Floor Plates, Surface Plates and Layout Tables made to specifications.

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GRAY IRON CASTINGS
(Up to 80,000 pounds)

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HYDE PARK FOUNDRY & MACHINE CO.
HYDE PARK, PA. (PITTSBURGH DISTRICT)

ANNOUNCING.....
THE NEW SPLIT-TYPE
DRAVO CRANE CAB COOLER . . .

Now available for installation on all types of cranes operating in HOT SPOTS

OVER:
SOAKING PITS
OPEN HEARTH FURNACES
BESSEMER CONVERTER
STRIPPING OPERATIONS
BLAST FURNACES
FOUNDRIES
PULPITS

The new Split-Type Crane Cab Cooler is completely installed on the crane by Dravo in two sections—the condenser section *on the crane*, wherever you want it . . . the cooling section *in the cab*, with the operator. The two sections are joined only with refrigerant pipe and electrical connections.

ADAPTABLE TO SUIT YOUR REQUIREMENTS

The condenser section may be placed *anywhere* on the crane as your space limitations permit. Split-type units are ideal where cabs are located in the center of the crane.

COMPACT COOLING SECTION ELIMINATES DUCT WORK

The cooling section, in an attractive aluminum-finish metal cabinet, is installed out-of-the-way in the cab itself . . . requires no duct work . . . provides reliable 'round-the-clock service.

THERMOSTATIC CONTROLS MAINTAIN EVEN TEMPERATURE

Designed with thermostatic control and automatic operation, the Dravo Crane Cab Cooler maintains 80°—85° F. in summer when the ambient temperature is 175° F; and 68°—72° F. in winter with the ambient temperature at 0° F.

FURNISHES COMPLETE YEAR-'ROUND AIR CONDITIONING

In the various air conditioning functions the split-type cooler not only filters the air, removes dust, dirt and fumes, but heats the cab in winter, cools it in summer and provides constant ventilation the year around.

STRONG CONSTRUCTION FOR LONG SERVICE LIFE

Dravo Crane Cab Coolers are ruggedly constructed, factory assembled and pre-tested to provide years of more-than-satisfactory service. All equipment in the unit is readily accessible with ample space for quick and efficient maintenance.

AVAILABLE FOR IMMEDIATE INSTALLATION

The new Dravo Split-Type Crane Cab Cooler can be easily and quickly installed on any type of crane with a minimum of down-time required. Units are available now! Write for more information—or phone the nearest Dravo Office and have our representative call on you.

DRAVO

DRAVO CORPORATION

DRAVO BUILDING, PITTSBURGH 22, PA.

PITTSBURGH • PHILADELPHIA • CLEVELAND • NEW YORK
CHICAGO • DETROIT • ATLANTA • BOSTON

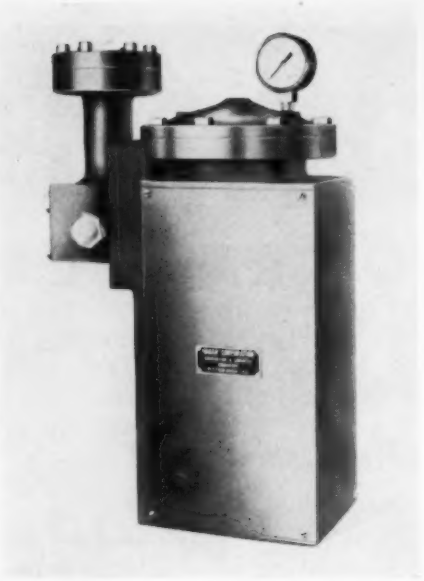
facturing Co. has been received by the Philadelphia division. It was revealed that a single order for 940 Yale gas fluid drive industrial trucks has been placed by the Navy's purchasing office. Production at the Philadelphia division of gas and electric industrial trucks and hoists has been more than doubled, in units, since last June.

The present distribution of Yale materials handling equipment is 35 per cent to the armed forces and other federal agencies, 50 per cent to defense-supporting industries, and 15 per cent to other civilian users.

FLOW SIGNAL UNIT

▲ Hagan Corp. announces the high pressure flow signal transmitter, a pneumatically operated flow differential measuring unit which transmits proportional signals to remote recording or indicating instruments, or to automatic control units.

The new transmitter is being applied successfully to virtually every condition of operation in process industries, to the metallurgical field and in steam power plants. It is used for measuring flow differentials of liquids, gases or vapors, or for measuring static pressure or liquid level.



This transmitter is being applied for measuring flow differentials.

Interchangeable measuring elements cover a continuous range of pressure differential from 5.5 in. water column to 100 psi, at static pressures up to 1500 psig.

The transmitter consists essentially of an input differential pressure measuring unit, force balanced by an output system. The balancing force originates in a modulated loading air pressure resulting from the action on an escapement type pilot valve following any unbalance of linkage forces.

The pressure differential across an orifice, flow nozzle or other primary device is connected to the measuring element, which is enclosed in a pressure chamber, and is designed for the maximum service required of the unit.

The torque produced by the pressure differential is balanced by the force produced by the modulated air pressure which is transmitted from the pilot valve to the balancing diaphragm. The force is transmitted by the diaphragm through a linkage system.

The output loading pressure has a maximum value of either 30 or 60 psig and may be linear with differential or with flow. The pressure is carried to an indicator, recorder or to an automatic control system through a single ¼-in. pipe. This makes for economical installation, flexibility of a centralized panel, and safety, because only a low air pressure goes to the control panels.

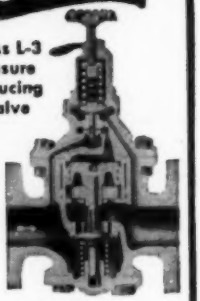
Inertia of the force balance system

LESLIE – the Reducing Valve and Temperature Regulator you will Want

Check the following list of features you don't expect but have always wanted to find in a Reducing Valve* or Temperature Regulator*:

1. Hardened & Ground Stainless Steel Main Valve
2. Stellited Seat for all pressures
3. Hardened & Ground Stainless Steel Pilot or Controlling Valve
4. Hardened & Ground Stainless Steel Cylinder Liner
5. Corrosion and Heat Resistant Alloy Internal Springs
6. Full Spring Temper Diaphragm for long life
7. Copper Clad Sheet Packing Gasket
8. Interchangeable Pilot Valve and Seat. Sizes ½"–6" incl.

Note how Leslie gives you all of them as standard equipment.



Class L-3 Pressure Reducing Valve

Class LTCO Temperature Regulator

*SEND FOR Bulletin 461B —Pressure Reducing Valves
Bulletin 464A—Temperature Regulators
Bulletin 468 —Interchangeability

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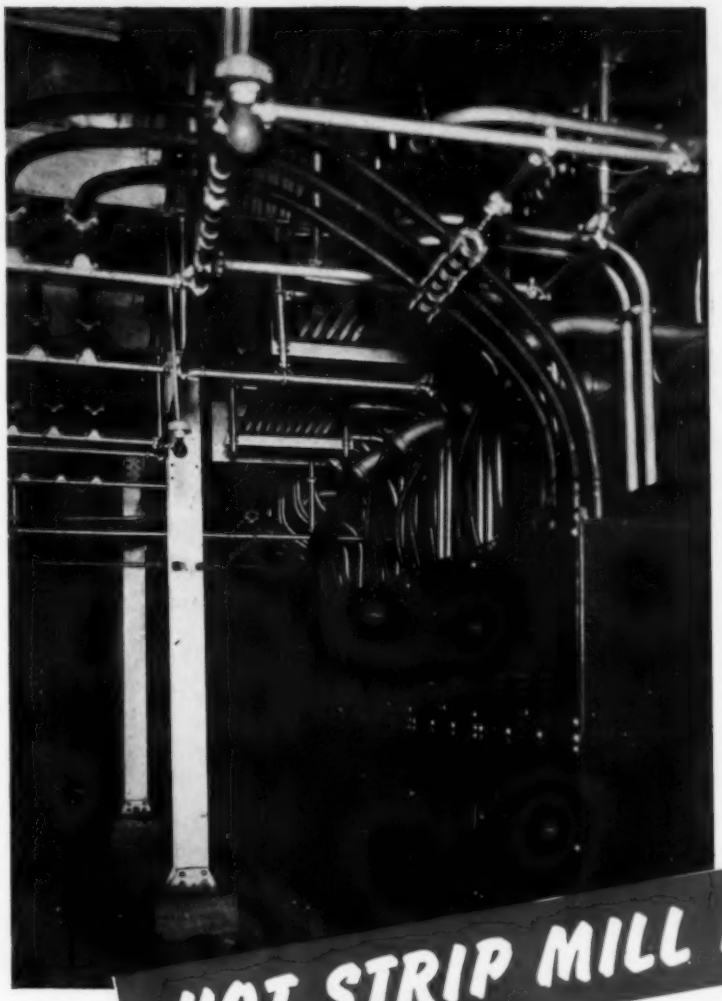
PRESSURE REDUCING VALVES • • PRESSURE CONTROLLERS
PUMP GOVERNORS • • • TEMPERATURE REGULATORS
SELF CLEANING STRAINERS • • LESLIE-TYFON WHISTLES



WHY IS OKOLITE-OKOPRENE THE CHOICE FOR HOT STRIP MILL POWER CIRCUITS?

HERE ARE SOME OF THE REASONS:

The Okoprene sheath, containing no rubber, will not rot or deteriorate when subject to moisture in underground service. It has better resistance to acids, alkalies, corrosive chemicals – and especially oils – than braid, lead, or other common cable coverings. Will not deteriorate at heats even as high as 167°F. Okolite-Okoprene cables do not require a lead sheath.

The Okolite insulation resists moisture and heat to virtually the same degree as the Okoprene sheath. Millions of feet of Okolite-Okoprene cables, under the toughest service conditions, have proved their superior insulating strength, aging properties and stability.

Okonite cables are the only cables on the market on which the insulation and sheath are applied by the strip process. This method of application makes a profound difference in the cable's endurance. For instance, the insulation is not "worked" as it must be for the extrusion method; insulation and covering are applied in one operation and vulcanized but once; a much more dependable bond between the two is thus obtained.

Most conclusive evidence of Okonite cable superiority is the a-c and d-c super-voltage testing routinely applied during its manufacture – the highest voltage cable testing in use anywhere. No other cable manufacturer offers this positive assurance for trouble-free service.

Much of the $50,000,000 worth of electrical equipment to go into steel mills this year will be served by Okonite wires and cables. Bulletin IS-1053 gives *all* the reasons why. Write for this bulletin today, to The Okonite Company, Passaic, N. J.

OKONITE SINCE 1878

THE BEST CABLE IS YOUR BEST POLICY

insulated wires and cables

9054

is negligible. The transmitter has no pressure type bearings or stuffing boxes. Since no manometric sealing fluid is required, there is no contamination problem in process plants.

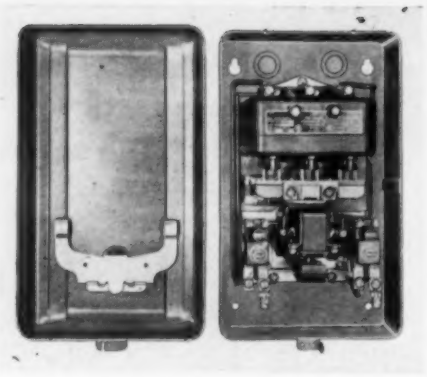
Accuracy of measurement is within one per cent of full scale reading. A change of only 0.1 per cent in applied pressure differential will effect a reproducible change in loading pressure when sending maximum loading pressure.

A-C MOTOR STARTER

▲ The new Clark CY-2 starter for a-c motors introduces a new arc interrupting principle to the control industry.

The feature of the starter is the combined use of strong multi-turn magnetic blowouts with twin break contacts. The advantages of both are combined in economical space. A steel case, enclosing each arc chamber, carries the flux, and provides the ultimate in non-carbonizing.

The arc is extinguished by applying the effect of the blowout coil concentric with the contact. The steel arc chamber and center stud form the magnetic circuit around each contact. The magnetic field is concentrated in a cone from the steel center stud supporting the upper contact, to the steel rim in the lower arc shield surrounding the lower contact.



Featured in this new a-c motor starter is a new arc interrupting principle.

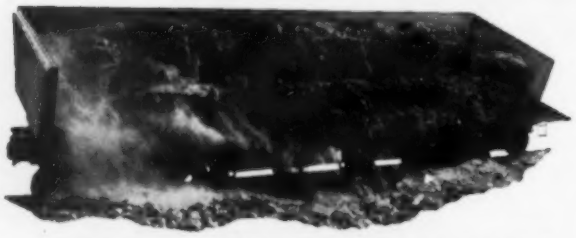
Two different actions occur, changing each half cycle with the reversal of the current. In one current direction the arc is forced to the outer edge of the upper contact, lengthened and rotated. In the other, the arc is rotated and forced to the middle of the upper contact. In each case, the magnetic field tends to extinguish the arc, either by lengthening it or confining it.

The most important action is the constant moving of the arc. In its forced rotation, it must continually move from a hot spot to a relatively cool spot. The result is highly efficient and extremely effective arc interruption.

This arc chamber is the ultimate in electrical control design. No carbonizing of insulating material can occur because all parts in the arc chamber are copper, brass and steel.

The action of the blowouts assures that any arcing that occurs will be spread uniformly over the entire contact surfaces, thus minimizing burning and pitting of contacts. After frequent operation on a heavy load, the clean appearance of the contacts is amazing. The absence of carbon and soot means longer contact life, and lower operating temperatures. In addition, the top of the arc chamber is closed, thus preventing accumulation of the ionized gases between the wiring terminals. This factor minimizes phase to phase failures.

GENERATION of SERVICE
RUGGED & DEPENDABLE



MAGOR AIR DUMP CARS

Built for Steel Plant Service, Magor Air Dump Cars will operate at maximum efficiency for as long as 30 years.

Maintenance costs are less — almost 50% less than gondola, hopper or outmoded air dump cars. Every feature of Magor Air Dump Cars is designed to stand up under the tremendous strain of continuous operation.

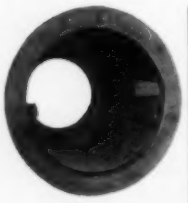
Magor Air Dump Cars can cut your refuse disposal costs as much as 40%.

Write for Bulletin DS-102.

MAGOR CAR CORPORATION, 50 CHURCH ST., NEW YORK, N. Y.
World's Largest Producer of Air Dump Cars

Delivered WHEN you want them
*... and in the BEST quality**

COPPER



Valve Seats
Valve Gates
Inwall Plates
Bosh Plates
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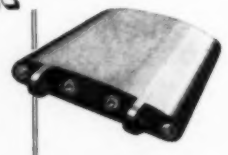
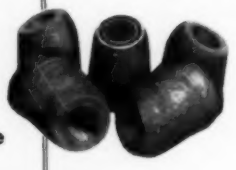
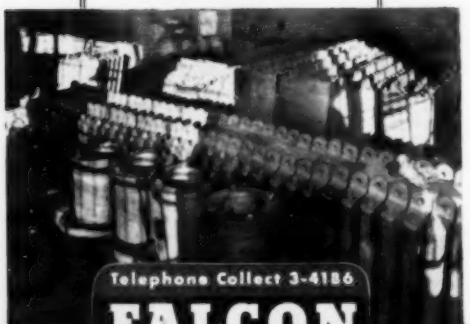
Monkeys





Copper and Bronze Castings



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FALCON BRONZE CO.
YOUNGSTOWN 3, OHIO
Established 1890 - Incorporated 1895

LICENSED MAKERS OF ALL PATENTED DESIGNS

*DEPENDABLE FOR 61 YEARS, SINCE 1890

TODAY, when our country is confronted with another state of emergency, The Kuljian Corporation is prepared to undertake challenging engineering tasks. The company's past achievements constitute a criterion by which its present capabilities can be judged and appraised. As it should be in time of war and national emergency, priority will be given to defense projects, and The Kuljian Corporation will again perform outstanding services "beyond those normally required."

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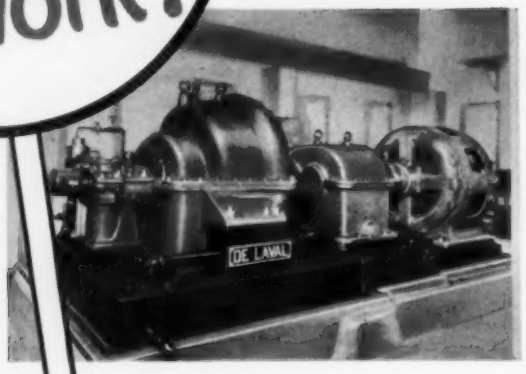
1200 NORTH BROAD STREET, PHILADELPHIA 21, PA.

De Laval Blowers at work!

Birds-eye View of 343,000 C.F.M.

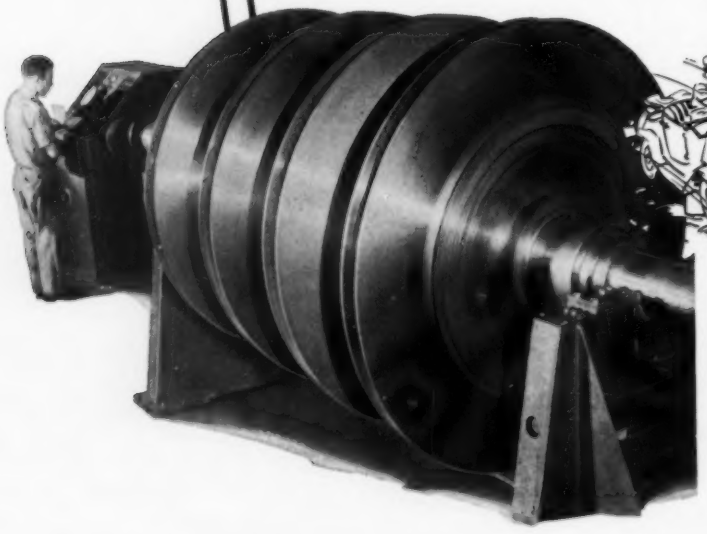
That's the combined capacity of these three big De Laval blast furnace blowers installed at the Edgar Thomson Works of Carnegie-Illinois Steel Corporation. Every day they handle enough air to fill a four foot square tunnel from Manila to Madrid and back to Miami. What's more, blast furnaces aren't shut down till they need relining and it takes husky, heavy duty machines like these to stand up for long periods of continuous operation.

For your next blower, be sure to get more than just a birdseye view of a De Laval unit. Let our engineers show you the whole picture.



They forgot the rule book for this blower!

We would never recommend that a centrifugal blower be opened for inspection only once every 22 years. Yet this De Laval two-stage machine in the Houston, Texas Sewage Disposal Plant was recently opened for the first time since it was installed in 1928 . . . *the blower and gear were in near perfect condition!* Our service man only had to clean up the journals a bit and put the unit back in service. If heavy-duty, continuous service is important, take your cue from this. We build 'em to last.



Stopping vibration before it starts!

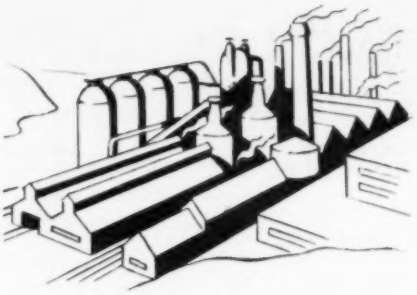
If a cat's whisker could hang onto the edge of one of these spinning blower wheels, the unbalance it created would show up on the dials of this dynamic balancer. Any unbalance, no matter how slight, can be detected and corrected right here. This is just one of the ways we build extra years of service into a De Laval blower.

DE LAVAL STEAM TURBINE CO., TRENTON 2, N. J.

TURBINES • HELICAL GEARS • CENTRIFUGAL BLOWERS AND COMPRESSORS
CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

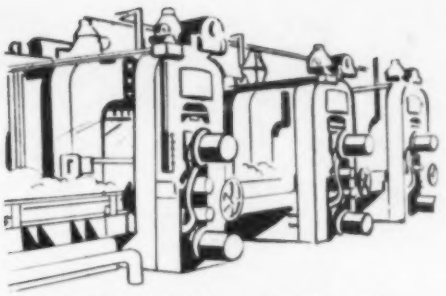
50th DE LAVAL Anniversary

C-17

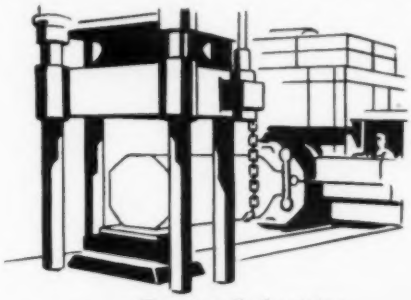


Steel Producing Plants

WHEN A REGULAR LUBRICANT ISN'T GOOD ENOUGH . . .



Hot Strip, Cold Reduction and Temper Pass Mills



Forging Industries

SPECIFY LEADOLENE* Klingfast

The "I.P."* LUBRICANT

On the really tough jobs in the steel industry, the answer to vastly reduced lubricating costs and extended equipment life is *Leadolene Klingfast.* Capable of withstanding pressures up to 50,000 p.s.i., this lead-base lubricant with its "indestructible pH-ilm" has proved itself repeatedly on the most difficult applications.

For efficient lubrication in the presence of water . . . for extreme adhesiveness to steel under high heat conditions . . . for unexcelled abrasion and corrosion-resistance . . . for actual cash savings up to 400 per cent—investigate the performance characteristics of *Leadolene Klingfast.*

CHECK THESE 9 IMPORTANT FACTS:

1. **EXTREME PRESSURE pH-ilm STRENGTH** of 50,000 lbs. per square inch minimum by "Timken" testing machine.
2. **ADHESIVENESS** in which affinity for steel and other metals develops maximum adhesion and prevents drippage or creeping. Retains a flexible coating in nature.
3. **WATER REPELLENCE** which retards washing off, creates a lubricating pH-ilm under moisture or water conditions.
4. **CORROSION PREVENTION** is an excellent protective coating in that it will not etch or corrode metals. Is never acidic.
5. **COMPOUNDED STABILITY**—Will not bleed or change physical condition within range of higher than usual temperatures for this type of lubricant.
6. **LOW TEMPERATURE FACTORS**—While having a solidifying action by decreased temperature as low as —40 F., it does not harden, crack or decrease in adhesion. The flexible coating withstands distortion of the application.
7. **ABRASIVE RESISTANCE**—Extremely high for a lubricant. Does not wipe off nor will be removed in handling by workmen's hands or gloves. Is extremely repellent to adhesion of scale, metallics and other forms of dusts or contamination.
8. Klingfast has remarkable corrosive resistance to salt or sea water, acidic vapors and solutions.
9. Klingfast can be removed by ordinary solvents such as kerosene, gasolene, naphtha, carbontetrachloride and similar substances but is highly impervious to lubricating oils and greases.

*I. P. . . . ("Indestructible pH-ilm" lubricant)

Write for 24-page descriptive booklet

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Since 1876

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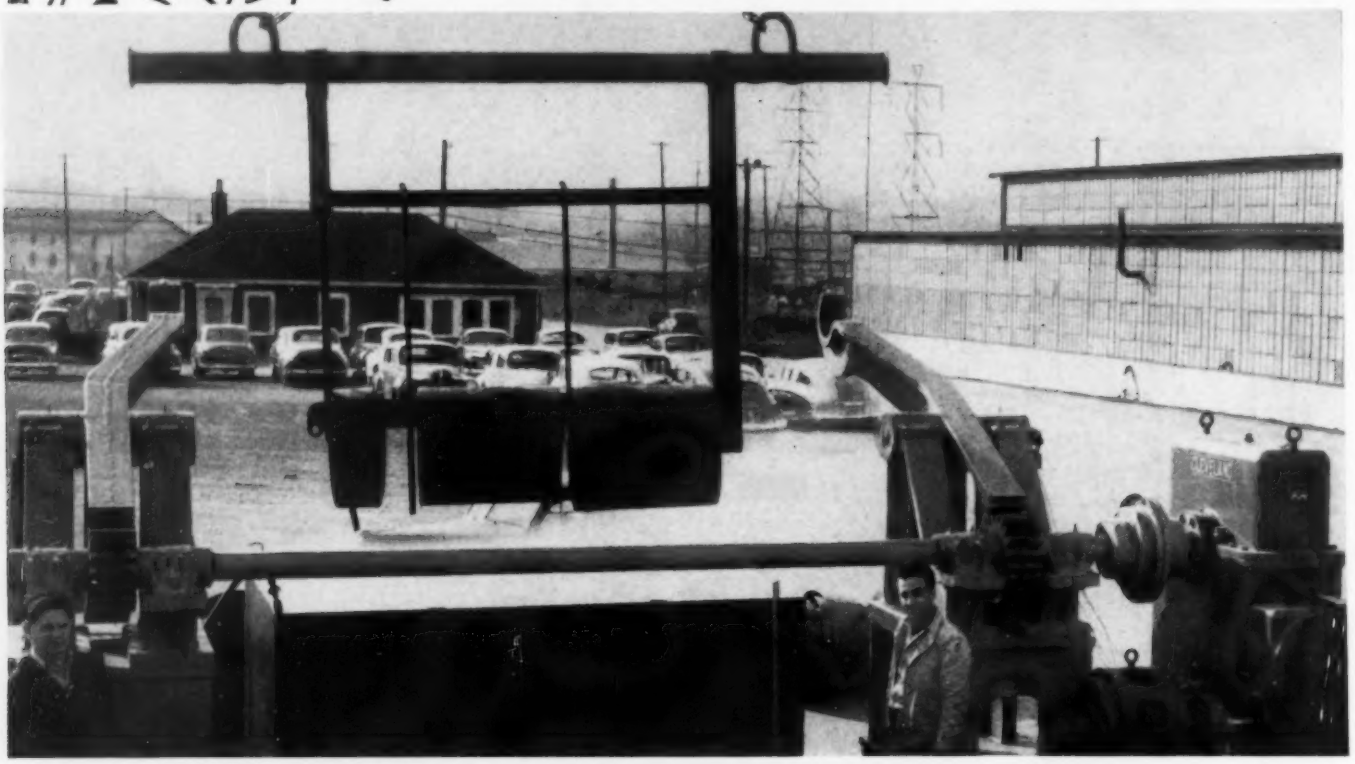
Warehouses: In Principal Industrial Cities

A LOW-COST COIL PICKLER DESIGNED ESPECIALLY for MEDIUM and LOW-TONNAGE MILLS



THE WELDCO MECHANICAL COIL PICKLER

SAVES SPACE • SAVES TIME
CUTS OPERATING and MAINTENANCE EXPENSE

Here, at last, is an economical, space-saving Coil Pickler, built especially for smaller mills that do not have continuous pickling. The Weldco Mechanical Coil Pickler handles strip, rod, or wire coils quickly and easily, requires very little space, cuts manpower, maintenance and operating expense 20% to 40%!

LOW INITIAL COST

A fraction of the cost of a Continuous Pickler.

No elaborate fume removal system is needed.

Only small pickling and wash tanks are required.

Less auxiliary equipment to install because, in the Weldco set-up, the coil is not uncoiled, then recoiled.

LOW MAINTENANCE COST

Simple, fool-proof mechanism — designed for maximum efficiency.

No damage or wear on tank, because the coil never touches the tank.

LOW OPERATING COST

Less steam consumption, because of the smaller tanks.

Less manpower needed.

Greater flexibility — several different widths can be pickled at the same time.

No down-time, because there's no resetting of equipment for different sizes.

No hairpinning required — another big time-saver!

SAVES PICKLING TIME

The up-and-down, side-to-side motion of the coil in the pickling bath removes the loose scale quickly, resulting in a completely clean, uniformly pickled surface.

The Weldco Mechanical Coil Pickler is available in any capacity, to meet your individual requirements. (For successful pickling of strip, a satisfactory scale breaker and a loose coiler are required.) Contact our Engineering Department for complete details on this new, low-cost Mechanical Coil Pickler — for complete engineering service on your entire pickling line.

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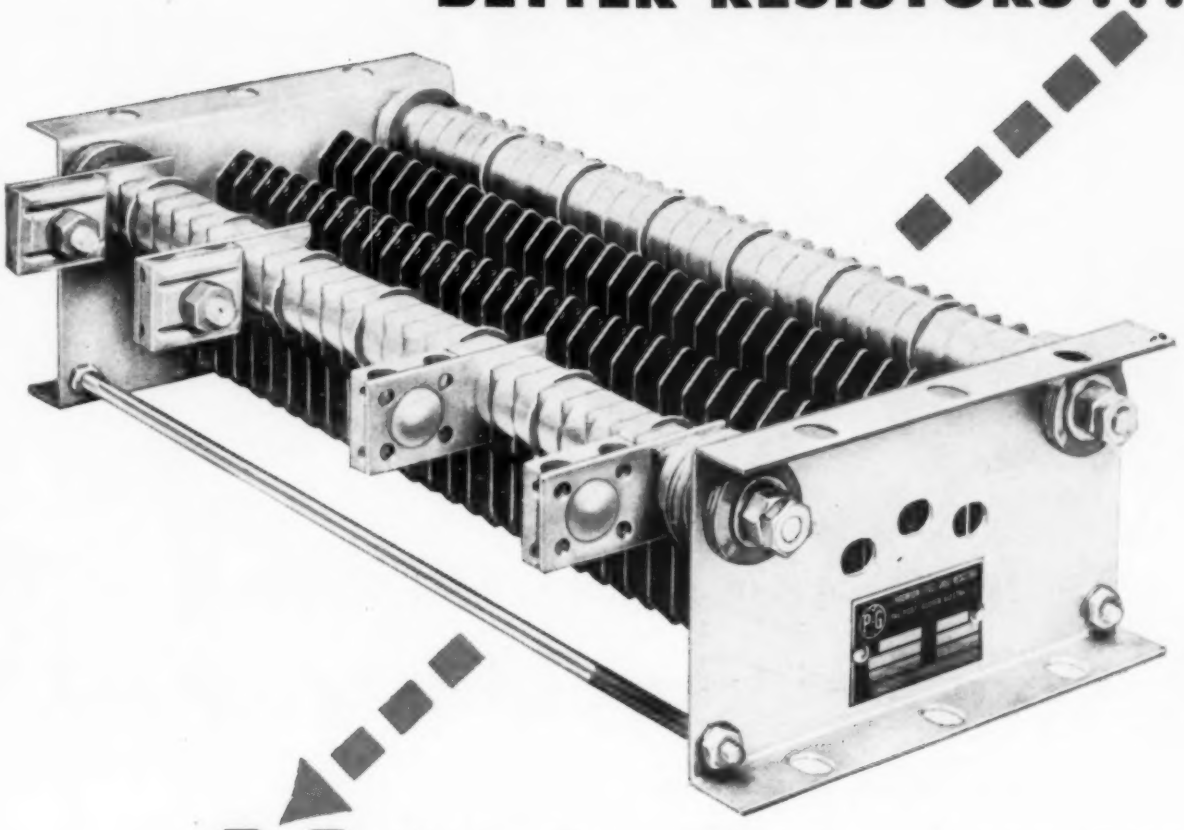
SEVERE MILL SERVICE *Demands*

BETTER RESISTORS...



P-G *Steel Grid Resistors* MEET EVERY REQUIREMENT FOR LONGER RESISTOR LIFE...

NON-BREAKABLE • ALL STEEL CONSTRUCTION • MICA INSULATION • CORROSION RESISTANT • UNAFFECTED BY VIBRATION OR MOISTURE • PROVISION FOR EXPANSION • ADEQUATE VENTILATION • RUGGED TERMINALS

These features, plus accurate resistance values and ample capacity ratings, make P-G the *better resistor*, capable of solving your resistor problems. Specify P-G for your next application, especially, if your operating conditions are *severe*.

Write for Bulletin No. 500

P-G

The Nonbreakable Steel Grid Resistor

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• ESTABLISHED 1892 •

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5 BRUSHES FOR MILL-TYPE MOTORS

join NATIONAL Carbon's famous standardized brushes!

In the table below, you will find the latest list of "National" standardized carbon brushes for steel mill applications.

Grade AX-5 was chosen because it has performed more successfully on mill motors than any other grade. Grade 401 has an equally impressive record on older type motors.

You get these brushes at the same low, flat price, whether you buy one box or 10,000 boxes. For convenience, order by NC-number.

STANDARDIZED BRUSHES FOR MILL-TYPE MOTORS

NC Number	A.I.S.E. Std. No.	Specifications		Applications
20-4800	29	2¼ x 1½ x ⅝	AX-5	MC 8-12-21-81-121 MD 104-406-408-412-416-418 W 610 K 4-KG4
20-5600	32	2¼ x 1¾ x ⅝	AX-5	MC 50-608 MD 410 K5-KG5
24-4800	38	2½ x 1½ x ¾	AX-5	MC 12-60-101-121-612-614 MD 418 MT 00-0
24-5600	40	2¼ x 1¾ x ¾ "Plytek" (⅜-⅜)	AX-5	MD 414-612-616
24-6400	42	2½ x 2 x ¾	401	MC 14-16-18-70-80-90-100 103-141-161-181-610 MD 420-421-422 SW 75-EW-FW-14W75- 18W150-K6-KG6

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FOR COMPLETE INFORMATION on National Carbon's brush standardization program and the advantages it offers, write to National Carbon Company, A Division of Union Carbide and Carbon Corporation, Dept. IS.

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With the revolutionary new "Eveready" No. 1050 Flashlight Battery, you get these big exclusive features:

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- Whitest, brightest light available from a flashlight battery
- Half the cost for light output
- Leakproof — No metal can to leak or corrode
- Will not swell, stick or jam in a flashlight

Why? Because of "Eveready" No. 1050's exclusive "inside out" construction. Instead of being the container for the cell, the zinc electrode is on the inside to make the battery last longer, while the new outside carbon jacket makes the battery leakproof. *Order a supply of No. 1050's today.*

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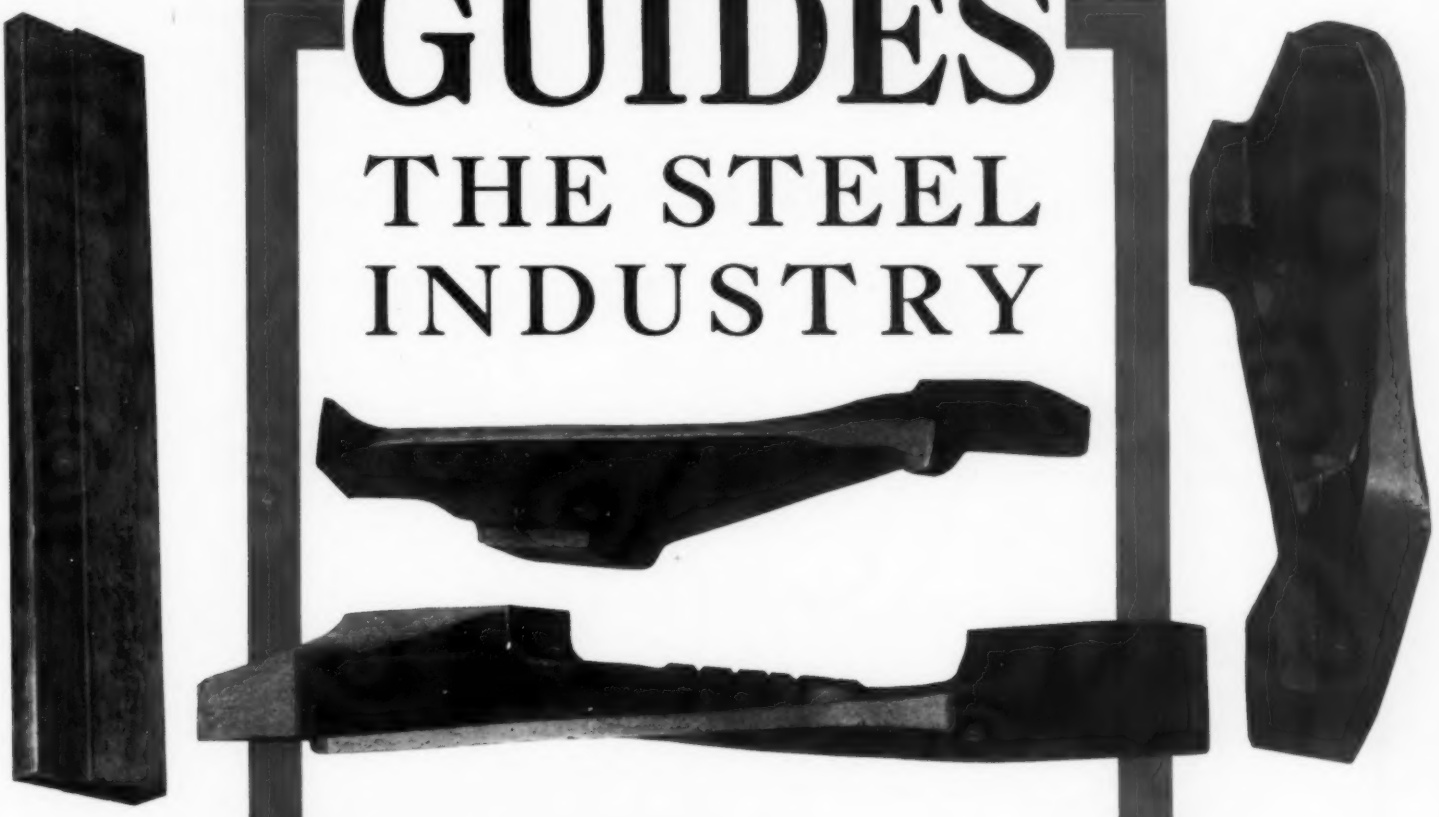

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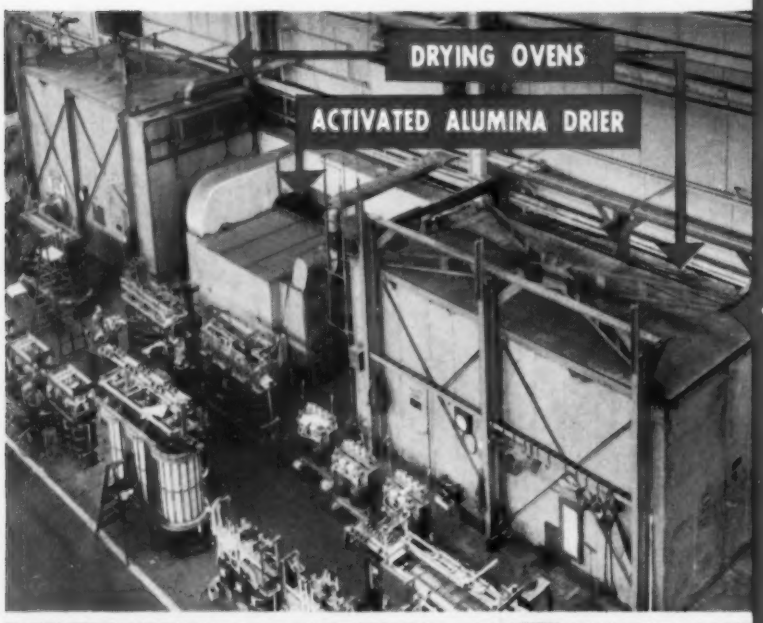
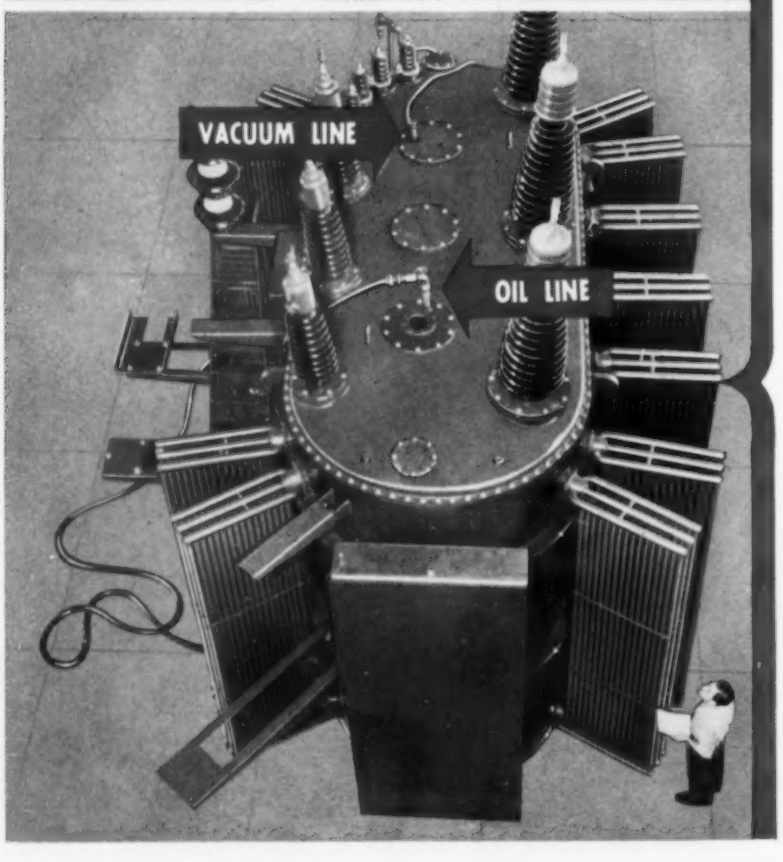
- **Drying out transformer core and coil units**
- **Filling transformer with oil**

These factory procedures, maintained under careful control at all times, are part of Pennsylvania's over-all program to provide America's Utilities and Industrials with the best power transformers that can be made.





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Pennsylvania's low-temperature, low-humidity drying equipment consists of two specially designed ovens and an elaborate activated alumina air-drying system.

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While they are still warm, transformers are removed from the ovens and placed directly into their respective cases. The core and coil units are not permitted to cool off and absorb moisture. By keeping the insulation dry, the low power factor values are maintained.

Oil Treatment of Completed Transformers

All power transformers are filled with de-aerated oil under vacuum in their own tanks.

Transformers designed for partial vacuum are placed inside a large vacuum tank. By breaking up the oil into a fine spray as it enters the transformer tank, the air is readily removed by high vacuum.

Transformers designed for full vacuum are evacuated in their own tanks. Oil is brought into the transformer through spray nozzles while a high vacuum is maintained in the tank.

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▲ SKF Industries, Inc., Philadelphia 32, Pa., announces that their 270-page book, "Ball And Roller Bearing Engineering," is for the first time being made generally available to engineers, product designers, maintenance men and engineering students. First published in 1945, this manual has since been regarded by the entire antifriction bearings industry as the most authoritative material ever published on the subject. The text covers in technical detail such subjects as bearing types and nomenclature, capacities, selection, design, installation, maintenance, causes of failures, and load calculations. In the interest of the present defense economy, SKF is offering copies to interested individuals in the continental United States only at the special price of $1.75.

▲**"Mechanical Measurements by Electrical Methods"** by Howard C. Roberts is a revised second edition published by Instruments Publishing Co., 912 Ridge Avenue, Pittsburgh, Pa. This book which consists of 357 pp, 4½ × 8 in. cloth bound sells for $4.00. The rapid developments in the instruments field has made it essential that the first edition be revised. The book is divided into two parts, the first part covers the basic principles of circuits and systems used and discusses capabilities and applications. In the second part, which covers equipment, the physical forms used in applying the principles are completely detailed. Circuits are shown for devices which are used throughout the engineering field. The book is a must for the instrument man, inasmuch as this equipment is finding wider applications throughout industry.

▲**"Metal Processing,"** by Orlan William Boston, has just been issued in a second edition by John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 763 pp, 6 × 9 in. cloth bound, price $7.50. Professor Boston is an internationally recognized authority in all types of machine tool, and metal working practices. The book gives complete information for preparation of routings, including the selection of machine tools, cutting tool materials, tool shapes, power speeds and feeds, and other accessories required for the plant layout and manufacture of a metal product. The second edition differs from the previous in that a chapter on surface quality has been added and the chapters on machinability, machine tool drives (including controls and circuits) have been markedly expanded.

▲The papers which were presented at the 43rd annual meeting (1950) of the Air Pollution and Smoke Prevention Association of America, Inc., which took place in Montreal, Canada, have been collected and assembled into a book. These papers range from discussions of smoke ordinances to steel industry activities on air pollution. Other subjects covered run from meteorological techniques to instrumentation. Authors are consulting engineers, industry engineers, railroad engineers, smoke inspectors and equipment manufacturers. The book may be obtained from John Paul Taylor, Publisher, 520 Pleasant St., St. Joseph, Mich. It is 122 pp, 8½ x 11 in., paper bound, price $5.00.

▲**"NEMA Standards for Large Air Circuit Breakers, Publication No. SG3-1951"** has been issued by NEMA, 155 East 44th Street, New York 17, N. Y., price $3.25. This publication contains practical information concerning the testing, rating, manufacturing, application and performance of low-voltage (750-v or less) air circuit breakers having interrupting ratings of 10,000 amp and above. Additional standards cover individually-enclosed and molded-case air circuit breakers, and instructions for the installation, operation and care of air circuit breakers are given.

▲**"Heating, Ventilating, Air Conditioning Guide—1951,"** Vol. 29, an annual publication of the ASHVE, has just been issued, and may be obtained from 51 Madison Avenue, New York 10, N. Y., 1456 pp 6 × 9 in. cloth bound, price $7.50 per copy. This guide brings up to date the latest developments on heating, ventilating and air conditioning. The arrangement of the book is similar to previous editions, although some space has been saved through condensation of certain sections which has been used to expand the data section.

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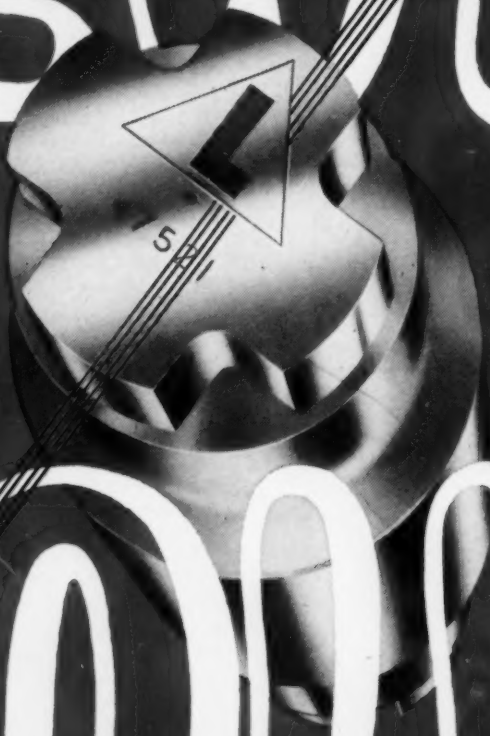

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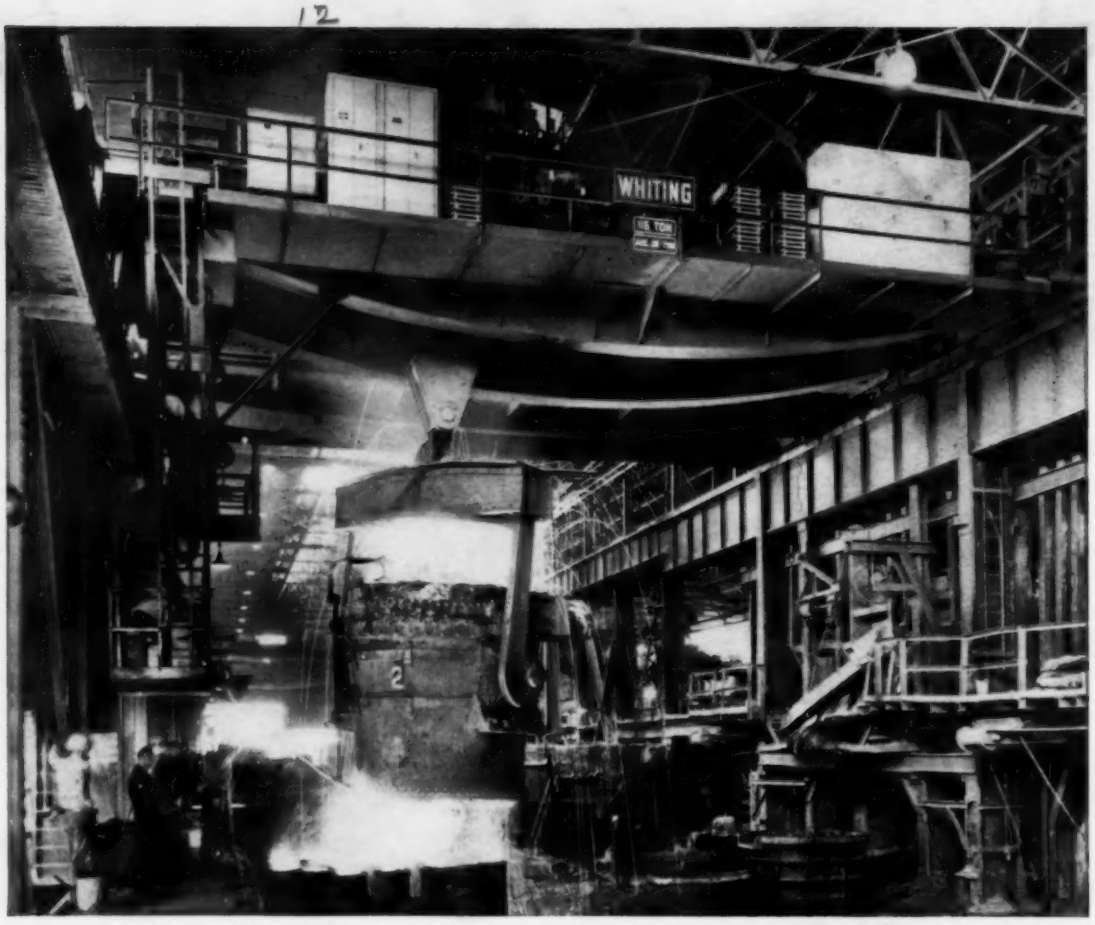

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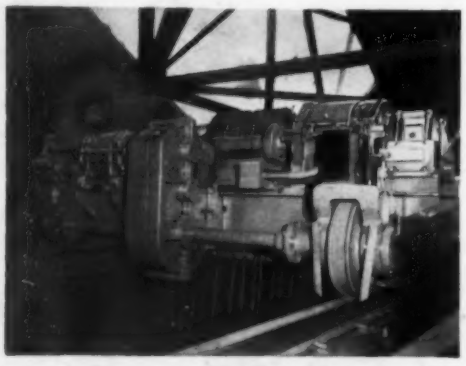

Close-up of main trolley shows (at right) the 65-hp main hoist motor with newly designed G-E d-c magnetic brake for quick, accurate stops. At left is the 19-hp G-E trolley motor. Both motors are MD-600's—toughest G-E mill motors ever built.

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